THIRTY-EIGHTH ANNUAL REPORT
FOR THE CALENDAR YEAR·· 1948

- Northern -
Rocky Mountain
Forest & Range
Experiment Station
Missoula Montana

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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THIRTY-EIGHTH ANNUAL REPORT

Introduction

Forest and range management research - what is it good for? And fire control studies? Are not forest fires a force to be dealt with on the ground, by marshalling manpower and equipment, and meeting force with force? What has Research got to do with it? What about forest economics and forest utilization studies? Is there too much economic planning, too much utilization? Flood control surveys? Better there were fewer surveys and more action. As for wildlife management investigations, what did the poor creatures do before man began to study and report on them and "manage" them?

No one conversant with the problems of managing wild land resources is likely to have such reactions to the seven-point research program indicated above and which is currently under way at the Northern Rocky Mountain Forest and Range Experiment Station. But many of the general public, if at all aware that such activities are under way, may well harbor such feelings. They are preoccupied with affairs remote from wild lands, and their skepticism stems from lack of appreciation of the importance of wild land resources and the measures necessary to build and maintain their productivity.

Attention is called to the following table:

Forest and Range Land in Percent of Total Land

	Total area	Forest land	Forest & Range combined (wild land)	Other land
	Million acres	- - - - -	Percent of Total - - - -	
Montana	93.6	26	74	26
North Idaho	12.5	83	91	9
Northeast Washington	5.0	78	84	16
Region I	111.1	35	77	23

It shows that 77 percent of the total land area of the Northern Rocky Mountain region is forest and range land. On these lands in 1947, some 731 sawmills cut 1,200 million board feet of lumber, valued at 105 million dollars. An additional 5½ million dollars' worth of transmission poles, pulpwood, and other items swelled the economy based

on forest products. This production helped materially to justify the boast now current that "the average Montanan receives 24 percent more income than the average American."

The livestock population of the region aggregates five million cattle and sheep valued at 370 million dollars. These animals are dependent on mountain and lower elevation ranges for part of their sustenance each year. Without these ranges, or with less productive range, such numbers could not be maintained, and our people would be deprived of a large part of the 70- to 100-million-dollar annual income from livestock.

It is clear that forest management research to determine the harvesting methods and care that will assure prompt regeneration of cutover lands, and grow more and better timber faster, is of vital import to the permanence and healthy growth of an invaluable forest industry.

To test and publish the methods by which range lands can be restored and maintained at full productivity is a challenging job cut out for range research.

Forest fire control is truly an action job - a big one, calling for expenditure of millions of federal, state, and private dollars every year. But Research can help. It has helped, materially, to reduce both costs and losses. It has done this by determining the factors affecting outbreak and spread of fire, devising means for their measurement, and placing in the hands of fire suppression organizations a guide for recognizing fire danger and manning accordingly. It has studied fire behavior, fuel types, fire occurrence and the action taken on thousands of fires. From such data it has determined principles of fire control planning and action that make the present protection dollar buy far more protection than it used to.

Forest economics research in this region means inventorying the forest resource - how much timber is there, where is it located, how fast is it growing, and what is the drain. It means analysis of such data with a view to helping industry and forest land managers plan their operations more efficiently.

The forest utilization service offered by the experiment station operates to assist established industry and to encourage new wood processing plants. Working closely with the Forest Products Laboratory it has demonstrated the suitability of hitherto little-used species for various purposes. Its long-term service tests of lodgepole pine, for example, are primarily responsible for an entirely new pole industry, which last year produced 350,000 poles valued at about three million dollars. The Utilization Service helps to reduce waste by bringing attention of operators to improved processing equipment and methods. It disseminates technical information on ways and means of converting plant and woods

up virtually to a watershed management research program.

The application of research information, and over-all justification for it, therefore, rests on a much broader base than mere timber and grass with related income and employment, important as they are. Information obtainable by research has a direct bearing on the success and permanence of the whole multi-billion dollar program for dams, irrigation, power, navigation, and flood control in the Missouri and Columbia Basins. Proper watershed management can knock the crest off flood waters, hold soil in place, deliver a sustained flow of clear water to downstream users. It can keep the reservoirs and irrigation systems from filling up with silt. It can help materially to keep America strong.

There is just one thing wrong with this picture. We in Research are not doing enough work fast enough. In our seven divisions we have but a nucleus of men and facilities. Despite our strategic location in the headwaters of two of the most important drainages in the country, we have no program for studying the influence of vegetative cover on water and its yield and seasonal availability. We know that the influence is beneficial. And forest managers, if they maintain the cover, are playing it safe. However, these wild land resources must be used. They are being used. If they are used without fullest regard for their influence on water and soil stability they can indeed be expensive luxuries. To illustrate: Forest Management research has proved that in certain timber types, a clear cutting operation is good silviculture - that a new crop will follow closely on logging. But the effect on water runoff and soil stability of laying the whole area bare would be disastrous. Perhaps only half a drainage should be cut at any one time. Perhaps that half should not be in one large block but in numerous smaller ones. How small? One hundred acres, fifty acres, or one acre? We do not know in quantitative terms the effect of such openings on snow accumulation, melt, and runoff. Foresters should know and engineers should know and be guided by that knowledge, thus bringing into play, on our side, natural forces that are quite as effective as dams and reservoirs in water conservation - and much less expensive.

DIVISION OF FOREST ECONOMICS

A. Accomplishments in 1948

Forest Resources

1. The major activity of this division in 1948 was the initial forest survey in eastern Montana and the maintenance survey in Idaho. In the initial survey special emphasis was placed on the possibilities of intensifying the present survey method to get local information. On the Gallatin National Forest, with funds set aside by the regional office, a method was developed to map in full forest type coverage and to take supplementary plot data. Such intensification suggests one way of reducing resource survey costs for local forest units.

   A minor activity was that of preparing a forest survey work plan for the other Rocky Mountain states. This task was assigned to this and the California stations jointly. Work on this assignment started in August and much of the basic data had been assembled by the end of the year.

2. For the first time this station received an allotment of funds for economic investigations. Using this a project was started in October studying the marketing problems of the Montana Christmas tree industry. As time permits an analysis is being made of the major regional economic problems which should be studied in the future.

3. Demands for forest resource information continued from many different quarters. During the year requests for data on pulpwood supplies in eastern Montana were received from pulpmills in the Lake States and from firms considering the establishment of pulpmills in the Inland Empire. Numerous requests were received also from lumber companies, railroads, and others interested in timber supplies.

   Government agencies made wide use of the survey data too. The Bureau of Land Management, Bureau of Reclamation, Fish and Wildlife Service, Soil Conservation Service, and 10 national forests sent in specific requests for resource information. In addition, four state forestry organizations used the forest survey material.

   In preparing flood control reports for both the Columbia and Missouri river basins extensive use was made of the forest survey statistics. Following the Columbia River flood the report on factors causing the flood leaned heavily on the survey data for areas of denuded and understocked forest lands.

4. The personnel status in the division stabilized during the year. Three men who had been on temporary appointments were given probational appointments from the Civil Service Register. Two regular appointees continued their educational leave and worked on the survey in the summer.

Forest Survey - Inventory

5. The inventory work was concentrated in eastern Montana and North Idaho. The field work of the inventory phase covered 28 counties, or about 5.9 million acres of forest land in eastern Montana. By the end of the year, 77 percent of all the field work and 56 percent of the total survey job in eastern Montana and those parts of South Dakota and Wyoming in Region 1 had been completed. Office computation of the inventory data was about one-third done.

In the resurvey of North Idaho three counties, Bonner, Kootenai, and Shoshone, were covered in the field. This amounted to a survey of about 2-1/2 million acres of forest land. Only a small part of the data has been compiled. In Washington, where the field work was completed the previous year, computation was about finished at the end of 1948.

6. A revised manual of field instructions for the initial survey was released in April. This manual explains in detail the field procedure now being used and defines the survey terms.

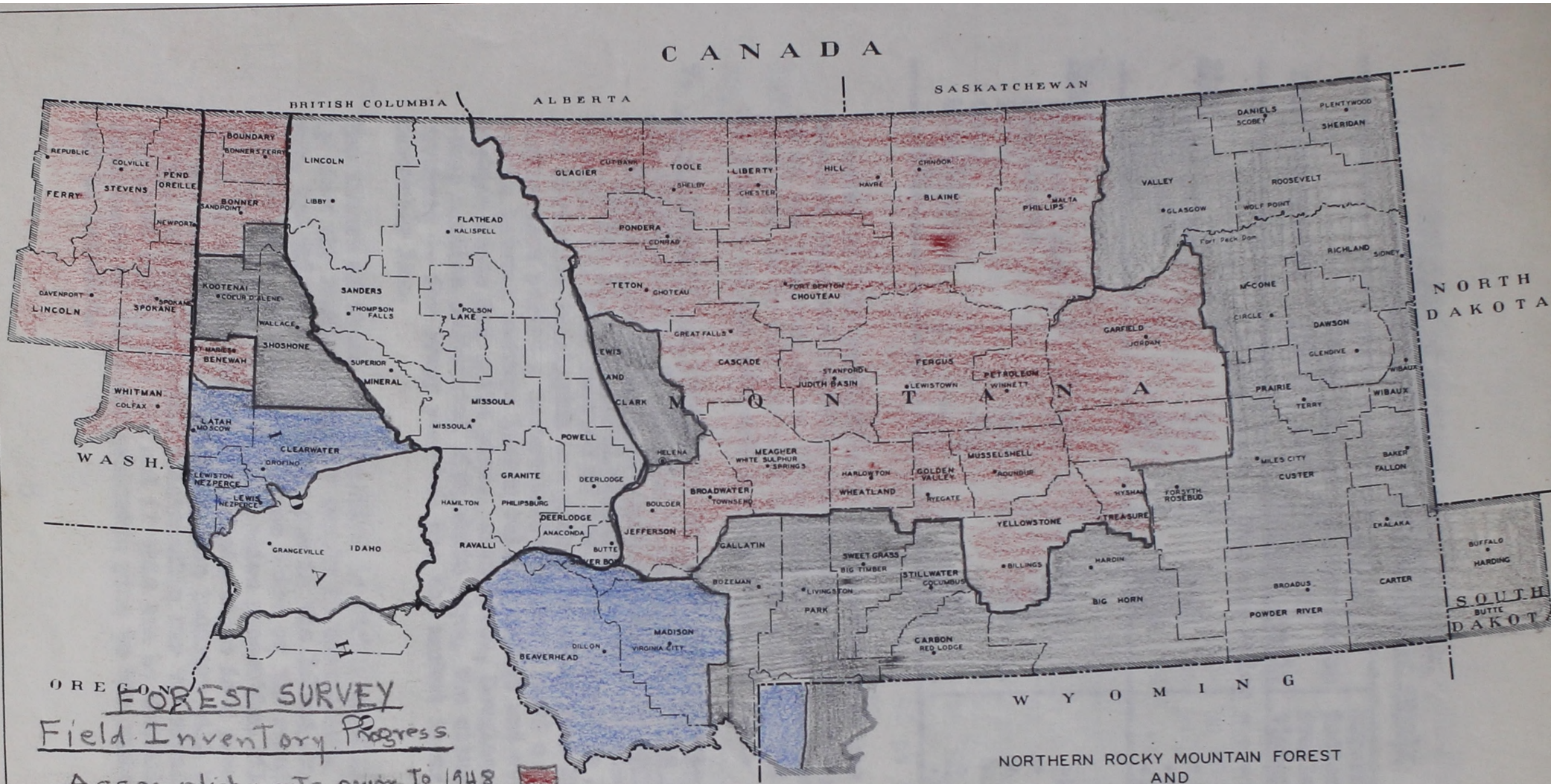
7. The following table summaries the status of the forest survey in Region 1 by forest survey units:

Status of the Forest Survey Program
(as of Dec. 31, 1948)

Item	Eastern Montana	Northeast Washington	North Idaho	Montana	Total Region 1
1. Type of survey	Initial	Resurvey	Resurvey	Resurvey	
2. Total forest area to be inventoried - M acres	11,428	4,002	10,318	14,093	39,844
3. Field inventory area 1946 through 1948 - M acres	8,846	4,002	4,098	-	16,946
4. Percent of field work completed as of Dec. 1948	77	100	40	-	43
5. Field inventory area in 1948 - M acres	5,748	-	2,508	-	8,256
6. Percent of total survey job completed as of Dec. 1948	56	98	39	2	37
7. Cost of survey from 1946 through 1948 - Cents per acre	1.02	.73	1.06	1.11	.94

Forest Industry Analysis

6. A study of pole production and timber resources suitable for poles showed that the pole industry can greatly expand its production in this area. Greatest expansion should come in the small pole classes and in lodgepole pine and Douglas-fir. The extent of the potential expansion is indicated in the following table:



FOREST SURVEY

Field Inventory Progress

Accomplishments prior To 1948

Accomplishments during 1948

Planned for 1949

NORTHERN ROCKY MOUNTAIN FOREST
AND
RANGE EXPERIMENT STATION
MISSOULA MONTANA

Relation of Northern Rocky Mountain pole production to available timber supply

Size and species	Pole production - 1947	Desirable production on basis of timber supply	Expansion indicated by available timber supply
	Thousand Poles		
Size			
Large poles	175	1046	+ 871
Small poles	642	2006	+1364
Total	817	3052	+2235
Species			
Lodgepole pine	352	1440	+1088
Douglas-fir	6	870	+ 864
Larch	222	336	+ 114
Cedar	231	210	- 21
Miscellaneous	6	196	+ 190
Total	817	3052	+2235

A survey of pole production in cooperation with the Rocky Mountain Pole and Treating Association showed that pole production is on the increase -- up 15 percent in 1947 over 1946. Lodgepole pine is by far the most important pole species making up 43 percent of the pole cut in this region in 1947.

7. An analysis of the importance of white and ponderosa pine in the lumber economy of the Inland Empire emphasized the extent to which the majority of the sawmills have been dependent upon pine timber to carry their operations. For example, from 1921 through 1940 three fourths of the lumber output in North Idaho and Northeast Washington was pine. In every year except one during that period a marketability index showed a favorable margin between average lumber selling values and average production costs for white pine. With larch, Douglas-fir and the other species associated with white pine, the situation was reversed -- for every year but one the market index was unfavorably low.

The import of these relationships is highly significant, especially when the remaining timber supply is considered. Prior to the war, two thirds of the lumber cut in the Inland Empire was pine, whereas pine represents only one third of the remaining timber supply. Clearly, a shift in species production will be necessitated in the near future but unless there is a pronounced change in the cost-price relationship, the industry will be in difficulty. A more favorable relationship for the mixed species developed during the war and if this can be maintained the importance of white and ponderosa pine to the lumber industry may be lessened.

8. Indications are that the pulpwood industry is continuing to expand. This is a desirable development for it provides an outlet for much of the timber in the region which in former years has not been used. Shipment of pulpwood from eastern Montana to the Lake States, which started experimentally in 1945, has increased and in 1947 a survey showed that about 25,000 cords of 100-inch pulpwood moved eastward. This is only a small increase over 1946, but it is believed that the rate of production was stepped up appreciably in 1948. Cutting of sawlogs for pulpwood went up about 75 percent in 1947 over 1946. In all the timber drain resulting from pulpwood cutting amounted to nearly 130 thousand cords in 1947.

9. While other forest industries tended to expand the Christmas tree production dropped sharply. From a high of 3.3 million trees in 1946 cutting went down to 2.5 million in 1947 -- a drop of 24 percent. This sharp decline was not due to a depletion of the resource but was attributed to the occurrence of a needle blight on Douglas-fir and a shortage of personnel for administering sales on public lands. Although cutting was down, distribution of Montana trees was widespread. Records show that trees from this region went to 31 different states -- as far east as New York, south to Texas and west to the Coast.

Forest Resource Analysis

10. Forest Resources of Northern Montana was the title of a progress report for the initial forest survey in eastern Montana. This 20-page report summarizes the forest land area and timber volume for 19 counties and presents detailed data by species, stand-size classes, and class of material for all the counties combined. Most of the forests covered in this report are in, or adjoining, the Great Plains country. Douglas-fir, cottonwood, and lodgepole pine are the principal species. Though not extensive, these forests, which cover only 3 percent of the total land area, are so concentrated that they have had an important place in the development of the Great Plains region and are a significant factor in protecting the upper Missouri River watershed.

11. A county statistical report based on survey data collected prior to the war was issued for Cascade County, Montana. The significant points brought out in this report were that about one fifth of the county is forested, almost three fourths of the forest land will grow commercial timber, the public owns most of the forest land, and 75 percent of the timber volume is in cordwood trees. Although the county has over 100 million board feet of saw timber, much of this volume is in relatively inaccessible areas.

12. A comparison of results of a resurvey in 1947 of six counties in Northeast Washington with results of the initial survey of the same six counties in 1934 showed some interesting changes. The total area of commercial forest land decreased only slightly. There were, however, sizeable changes in areas under various stand-size classes. Saw-timber and seedling-sapling areas decreased 33 M and 214 M acres, respectively. On the other hand, the area of pole stands went up 46 M acres. Deforested land increased by 156 M acres. Saw-timber volume increased from 14.6 billion board feet in the initial survey to 15.3 billion in the resurvey.

13. Growth of individual trees was the subject of station paper 11. This release presented 12 tables which give the board-foot and percent growth for ponderosa pine, western larch, and white pine trees of various sizes. For example, where there are eight growth rings in the outer radial inch the table for ponderosa pine in Montana shows the gross average annual growth is 25 board feet for a 26-inch d.b.h. tree. Another table shows that the same tree is growing at a rate of 4 percent annually. Field men, especially those marking timber for cutting, have found such tables a handy guide for deciding which trees to leave and which to cut.

14. Another study in the field of forest measurements revealed the effect of bark growth in determining periodic growth of individual trees. It might seem that bark growth would be an unimportant factor but an analysis of forest survey bark measurements showed that bark increment is a significant point in volume growth estimates. For example, a ponderosa pine tree 16 inches outside bark at breast height which added 6 inches of solid wood to its diameter in the past 30 years would have had a diameter of 9.5 inches at the beginning of the 30-year period because the bark grew 0.25 inches at the same time. If the bark growth is not considered the diameter 30 years ago would be calculated as 10.0 inches. The effect on volume would be:

	No allowance for bark growth	With allowance for bark growth
	Cubic feet inside bark	
Volume at present	26.0	26.0
Volume 30 years ago	9.5	8.6
Increase in volume	16.5	17.4
Underestimate of growth	5%	--

15. Results of a study of blister rust control in the Inland Empire were published. The authors point out many difficulties and handicaps involved in growing white pine in the Inland Empire. They conclude, however, that pine is worth the effort and cost, if future blister rust control work is tightly coordinated with other management and if silvicultural practices are carried out at a level of intensity comparable with blister rust control. Following is a brief summary of the main conclusions reached in this 116-page report:

a. That the Forest Service launch an aggressive campaign to grow continuous crops of white pine. From now on make it a WHITE PINE PROJECT instead of a blister rust control project.

b. That the white pine project should be developed on whatever scale appropriations permit with the work always concentrated in those units which will give the largest stable output of white pine for the money spent.

c. That a great deal of emphasis should be put into developing cheaper control methods, a stable program, and more effective blister rust control workers.

d. That there should be an aggressive program to bring good management to all those lands, regardless of ownership, which have been dedicated to growing white pine because of high productivity and relative economy of treatment.

e. That, however, the limitations of mixed ownership be realistically faced. And, that provision be made to simplify the land ownership pattern where adequate management by every owner is not assured.

f. That the objective in this region should be to grow an amount of white pine in keeping with regional and national needs.

g. That in fulfillment of these objectives, we should spend four million dollars annually during the next five years for blister rust control and white pine management on the national forests. After that, for 15 years the expenditure should be about 1-1/2 million dollars annually.

16. A study of river-drive damage to white pine logs was undertaken at the request of and in cooperation with the Diamond Match Company. Three station divisions: Forest Utilization Service, Forest Management, and Forest Economics, took part in the study. Each year the Diamond Match Company drives about 80 million board feet of white pine logs down the Priest and Pend Oreille rivers to its mills at Newport and Cusick, Washington. In the process of transportation many of the logs are damaged by breakage, splits, blue stain, and worm holes. The Company asked the experiment station to determine the extent of this river damage, for the purpose of deciding whether the savings involved in river driving are more than offset by the losses occurring in the process.

Mill-scale studies were conducted periodically for six months. They indicated that the damage attributable to river driving (but not including logs lost in transit) reduced the value of the lumber produced at the Newport mill by about 4 percent. Because blue stain is not allowed in match stock, match-plank yields are reduced about 12 percent by river damage. The following tabulation shows the reduction of match-plank yields by grades of material:

Lumber Grade	Percent reduction of match plank yield due to river damage
C & Better	27
D	21
Common	11
All grades	12

17. A study of Christmas tree marketing was begun during the fall of 1948. The cutting of 3 million Christmas trees in the average year provides a valuable source of income and employment for western Montana. However, the industry faces problems which threaten to undermine it in the long run. Quality of western Montana trees is said to be declining. Too many substandard trees are shipped to market.

Partly this matter of deterioration is a management problem. Partly it is a marketing problem. The Christmas tree marketing study, therefore, was undertaken to develop a clearer picture of the economics of the industry. Specifically, its objective has been to consider what might be done to improve the situation through the formation of producer associations, the tagging of trees, market information services, the adoption of grading rules, etc. Montana State University is cooperating in the study to the extent of collecting information on Christmas tree freight rates and trends of rates.

One of the by-products of this study has been some interesting information on costs involved in providing a tree for the average parlor. The $1.30 a family in Missouri might have paid for a six-foot tree in 1948 breaks down something like this:

Cost Items in the Retail Price of a Christmas Tree

Item	Cost	Percent of Total
Stumpage of landowner	$0.07	5
Cutting and yarding by cutter	.20	15
Hauling, baling, tagging and loading at concentration yard	.13	10
Concentrater charges	.09	7
Hauling by railroad	.13	10
Wholesaler charges	.23	18
Retailer charges	.45	35
	$1.30	100

B. Plans for 1949

Forest Survey - Inventory

1. Field work for the initial survey in eastern Montana is scheduled for completion during 1949. This will involve covering 1,300 M acres of commercial and 1,190 M acres of noncommercial forest land in Madison and Beaverhead Counties.

2. The maintenance survey field work will be continued in North Idaho. Counties scheduled for field coverage are Latah, Clearwater, Lewis, and Nezperce -- a total of about 2 million acres of forest land. Compilation of data will be continued.

Forest Industry Analysis

3. Plans are being made to continue the pole production survey in cooperation with the Rocky Mountain Pole and Treating Association.

4. Pulpwood and fuelwood production data will be assembled as in previous years. Special attention will be given to determining woods waste attributed to these products.

5. Lumber production data are to be obtained in cooperation with the Western Pine Association. Details of this project have not been fully developed as yet, but it is planned to get our timber drain data from this source. Waste studies initiated last year in Montana on sawlog operations will be continued in Idaho.

Forest Resource Analysis

6. The following statistical reports are scheduled for release during 1949:

Forest Resources of Southern Montana (15 counties)
Forest Resources of Unit I - Idaho (2 counties)
Forest Resources of Unit II - Idaho (2 counties)
Forest Resources of Northeast Washington (6 counties)

7. A preliminary draft of a comprehensive analytical report for Montana is scheduled for completion. This is to include the survey data for western and eastern Montana and will focus attention on the many contributions of forests to the economy of the state. Special emphasis will be placed on the importance of water which comes from forest lands.

Economics of Forest Management, Utilization, and Marketing

8. The study of Christmas tree marketing will be continued. Present plans call for preparing a station paper covering the results of the analysis of Christmas tree grading. In cooperation with the Forestry School of Montana State University, a bulletin will be published on the economic aspects of the Christmas tree industry in Montana.

9. A study of the pulpwood industry in astern Montana is being considered as a new project in 1949. It has been said many times during the past three decades that the construction of one or more pulpmills in Montana and northern Idaho would go a long way toward solving the timber utilization problem in this region. The existing lumber industry has been cutting white pine and ponderosa pine at a rate in excess of that which can be sustained. However, because of long distances from markets and other factors, larch, Douglas-fir, grand fir, hemlock, spruce, and lodgepole pine have not been utilized to the extent desirable. This factor has kept these two states from realizing as much revenue from forest products as they might and has complicated the forest management job because of the large areas cluttered with unusable timber. Each one of these underutilized species is suitable for pulp. Some of them are very good for this purpose. In the entire Northern Rocky Mountain region there is only one small pulpmill. That plant obtains no pulpwood from eastern Montana, and uses only a small part of the available wood supply in northern Idaho and western Montana. Thus, as far as wood supply is concerned, there is unquestionably room for the establishment of considerable pulpmill capacity. A great deal has been said in the past about the desirability of industrial expansion in these two states. Certainly one of the most likely possibilities for such expansion is in pulp and paper manufacture.

The fact that there may be room for several pulpmills in this region is of course significant from a national standpoint inasmuch as some other states are having difficulty meeting the wood requirements of their pulpmills. It is very significant to Montana and Idaho because such a development would materially affect the local economy. Yet, it is not a foregone conclusion that these states should go all out in promoting pulpmill expansion. We have the wood, but we have no basis for saying how much of a pulpmill development is feasible and desirable. Public land managers, faced with the responsibility of developing the most stable and desirable type of timber utilization, lack the understanding they should have for a properly oriented policy with regard to pulpwood development.

It is planned, during 1949 and 1950, to make a detailed analysis of the feasibility and desirability of a pulpmill industry in eastern Montana covering:

a. The extent of the timber supply available for pulping.

b. The consumption of pulp and paper products in the northern region.

c. The desirability of pulpmill development from the standpoint of the local economy.

d. Production and transportation cost factors relating to the feasibility of local pulpmill development.

e. Adequacy of labor supply.

f. Desirable State and Forest Service policy relating to pulpmill development in eastern Montana.

10. Results of the Diamond Match Company log damage study will be published during 1949 as a station paper.

FOREST UTILIZATION SERVICE

A. Accomplishments in 1948

1. **Wood-sugar molasses stock-feeding tests continued to produce good results.** Results of comparable feeding tests conducted at the Montana State College Agricultural Experiment Station on four lots of 17 lambs each showed no significant difference in gains of lambs fed on wood-sugar molasses and on cane molasses. A 50-50 mixture of oats and beet pulp was used for the base ration in the test. Wood sugar was fed in concentrations of 9 and 16-2/3 percent by weight, and the beet- and cane-sugar molasses at 9 percent.

Reports on dairy cattle under study at the Wyoming State College Agricultural Experiment Station further confirmed the fact that the addition of 5 percent wood-sugar molasses did not affect the palatability of the grain ration and the stock showed no preference to similar concentrations of cane-sugar molasses. The tests also revealed that the 5 percent wood sugar did not affect the flavor of the milk.

Studies were also arranged with the Montana State College to determine:

a. Nutritional value of wood molasses as compared to cane molasses.

b. Value of wood molasses when used in a lamb-fattening ration.

c. Value of wood molasses compared to cane molasses fed as a fattening ration to yearling steers.

d. Value of wood molasses as part of the carbohydrate ingredient of dairy cattle feed.

Preliminary results of these studies now available indicate that:

a. There was no significant difference in gains of lambs fattened on rations including wood molasses and those fattened on cane molasses.

b. No objectionable taste was imparted to the meat of lambs fed wood molasses.

c. Dairy cows fed wood molasses produced milk free from any unusual taste.

d. Steers fed wood molasses showed weight gains equal to those fed cane molasses.

e. No toxic effect due to feeding of wood molasses was noticed on either steers, lambs, or dairy cows.

2. The physical and mechanical properties of wood-sugar molasses were determined in stock-food pelleting tests. Through the facilities of Misco Mills, wood-sugar molasses was used for what is believed to be the first time in the United States in the production of pelleted stock foods. Pellets 3/4-inch in diameter and containing 5, 10, and 13 percent wood-sugar molasses were produced from the company's standard cattle and sheep dry-feed mixture. Two lots of wood-sugar molasses as supplied by the Forest Products Laboratory and containing approximately 55 and 39.7 percent sugar were tested. Test results indicated that with the type of equipment used molasses having a sugar concentration of not more than 45 percent would be most satisfactory. The molasses with the 55 percent sugar content was too heavy for the firm's pumping system and showed evidence of glucose crystallization. It is possible that with warm storage or through some means of heating the molasses before use this difficulty could be avoided.

It was the opinion of the company's representative that the quality of the wood-molasses pellets was equal to that of the ones bonded by cane molasses. The pellets containing 13 percent molasses appeared to be slightly better molded than those containing less molasses. Observations on the pellets since manufacture also indicate that they have good storage life.

3. A State advisory council was formed to facilitate and correlate the production and use of wood-sugar molasses and fodder yeast. Membership includes representatives of the Montana Wool Growers Association, Montana Stockgrowers Association, Inc., Montana Lumber Manufacturers' Association, Rocky Mountain Pole & Treating Association, Industrial Development Division of the Montana Chamber of Commerce, Montana State Veterinary Department, Montana State College Agricultural Experiment Station at Bozeman, and the Northern Rocky Mountain Forest and Range Experiment Station. In addition to functioning as a correlating agency, the council will also work out methods for financing the experimental work to be carried out.

4. The possibility of developing a local supply of wood-sugar molasses was studied. Dr. H. F. Mullikin, head of the Department of Mechanical Engineering at Montana State College, and Mr. R. W. Arboe, of the same department, visited the wood-molasses pilot plant at the Forest Products Laboratory in September. The purpose of the trip was to acquaint Dr. Mullikin with the process so that he could develop tentative specifications for a commercial plant compatible with Montana conditions, and to determine the possibility of installing a pilot plant at the college at Bozeman. A bill providing funds for such a pilot plant was

introduced in the 31st Montana Legislature but failed to pass. However, as a result of this effort interest in the establishment of a commercial wood-molasses plant in Montana runs high and at least three communities are considering such a venture.

5. Veneer-cutting tests to determine optimum temperature for the manufacture of western larch veneer were completed at the Forest Products Laboratory. The suitability of western larch for the production of veneer has been pretty well established both in the laboratory and by industry. The problem involved in this study was to determine whether it was necessary to heat the logs before cutting, and if so to what temperature. In this test all temperatures from room, or what is considered unheated, to 210° F., at intervals of 20°, were studied. The results showed that the optimum temperature was around 150° F. Veneer cut at temperatures above this point tended to become rough, while that cut at lower temperatures was less firm. The logs used in the tests were selected from a stand of mature larch located in the Swan River country just north of Seeley Lake, Montana.

6. The seasoning study on patented house logs was completed. The National Log Construction Company of Montana at Thompson Falls produces a turned-type of house log which is equipped with a tongue and groove and has a 3-inch hole drilled the entire length. The purpose of the hole is to accelerate seasoning, reduce weight, and possibly reduce some of the checking that commonly occurs in seasoning solid round timbers.

The design gave satisfactory results in the air-seasoning of ponderosa pine and lodgepole, but less so with western larch and Douglas-fir, the two most available species. The company considered kiln drying, but before going into the expense of such construction decided first to get some leads on the effectiveness of kiln drying. The Forest Products Laboratory was contacted, and as a result 44 turned and drilled house logs were shipped to Madison for study. The results of the Laboratory's investigation - which included various conventional kiln schedules, vapor seasoning, and threading the drilled logs on a steam pipe - showed that the method involving Saligna (formerly Myles Lumber Cure) was most effective in reducing the checking. The company plans to investigate commercial feasibility of this process.

7. A study to determine the amount of deterioration that occurs in white pine logs as a result of river-driving was completed for The Diamond Match Company. Several station divisions participated in this study. It is reported in some detail on page 12.

8. The first wood-laminating plant to be built in the Northern Rocky Mountain area is now in production. All facilities required to fabricate laminated mine guides were installed at the Anaconda Copper Mining Company's sawmill shortly before the close of the year. The company's decision to manufacture laminated guides is a direct result of the performance of a number of laminated guides installed in their mines a number of years ago under a cooperative experiment including the Forest Products Laboratory and Timber Structures, Inc. Initial production calls for an all-larch guide with the laminations next to the face and back set at 45° to the long axis of the member. Some consideration is also being given to the use of staypak as a guide-facing material to prevent damage caused by falling rocks. Two 16-foot sections of larch-staypak-faced guides were made up at the Forest Products Laboratory at the company's request and installed for experimental purposes.

9. Lignin from wood-molasses project increased chrysanthemum production. Professor F. M. Harrington of the Horticulture Department at Montana State College used lignin furnished by the Forest Products Laboratory as a soil conditioner in the greenhouse. His tentative results indicate that 'mums produced in the lignin soil had a 30-percent weight increase above those in the check plots. He cautions this is not a final conclusion but feels quite enthusiastic about the usefulness of lignin in the greenhouse.

10. Aged sawdust used as a soil conditioner improved sugar-beet yields. On the assumption that aged sawdust is largely lignin and similar in its properties to wood-molasses lignin, the Forest Utilization Service has encouraged the experimental use of aged sawdust as a soil conditioner. Ranger C. H. McDonald of the Stevensville District on the Bitterroot Forest carried the ball with beet producers in the Bitterroot Valley. One farmer, Joe Canton, treated a sugar-beet tract with 20 tons per acre of aged sawdust. The result was an 0.6-percent increase in sugar content and a 2-percent increase in the purity of the beets. There was a very noticeable betterment in the physical property of the soil. Mr. Canton plans to enlarge his use of aged sawdust. Farmers are, however, cautioned against the use of new sawdust without a strong nitrogen supplement.

11. A number of bug-killed lodgepole pine stands in the region were visited by Dr. Carl Hartley and Mr. Ralph M. Lindgren of the Bureau of Plant Industry for the purpose of determining the feasibility of undertaking a rate-of-deterioration study on the bug-killed material. Mueller along with forest and regional office representatives accompanied the visitors on their 2-day stay in the region. Final action will be based on results of similar investigations now being made in other portions of the lodgepole range where the infestation occurred.

12. A study was started to determine, through accelerated methods, the relative durability of the heartwood of the principal pole species found in the Northern Rocky Mountain area. The effect that site, age, and position of the heartwood in the tree have on the durability was also incorporated in the study.

Interest in this work stems from the pole industry of the area. This industry, contrary to some expectations, maintained a higher production in 1948 than for the previous year.

The information is urgently needed for western larch because of the almost total lack of this type of service-life data on the species when used as a pole. Interest in cedar stems from the thought that young, more rapidly grown trees are less durable than old-growth trees.

The work is being conducted by the Division of Forest Pathology at the Forest Products Laboratory. The Laboratory tests are being tied into three State plots that are located on the basis of light, medium, and severe exposures from the standpoint of decay.

13. Numerous other minor activities worthy of mention were carried on during the year. Correspondence of the unit increased during the year, when over 1,000 pieces were handled. It is worthy of note that considerable interest was shown in chemical utilization of wood, since 16 percent of all correspondence pertained to that subject. Cooperation with other public agencies such as State industrial development organizations, the Northwest Wood Products Clinic, and others accounted for 18 percent of the correspondence.

Over 100 members of the forest products industries of the Northern Rocky Mountain area called in person at the Missoula Forest Utilization Service office during the year and conferred on various wood-utilization problems.

A research task force to assist the National Military Establishment was formed during the year under the chairmanship of Chancellor G. A. Selke of The Greater University of Montana. I. V. Anderson represents the Northern Rocky Mountain Station on this task force, which is functioning under the Montana Industrial Development Division.

Members of the Forest Utilization Service again participated in the annual Northwest Wood Products Clinic held in Spokane, Washington, in April. Ray Rietz, timber physicist of the Forest Products Laboratory, led the panel on seasoning of poles and other round wood products.

Numerous speeches and papers on the various phases of wood utilization were presented at meetings during the year. Meetings included the American Wood-Preservers' Association annual meeting at St. Paul, where a paper was presented entitled "Pole Timber Supplies of the Northern and Far Western States and a Look at Production Problems."

B. Plans for 1949

1. The forest-products research program for the Northern Rocky Mountain area is one of long-term objectives. To keep the program directed toward accomplishment of these objectives requires (a) current analysis of the problems of the wood user and (b) application of the results of research as soon as they come out of the Laboratory. Correlation of the Madison Laboratory research program with that of other public agencies and industrial research organizations is a "must."

2. The over-all aim of the correlated forest-products research program is optimum forest practice on all forest lands of the Northern Rocky Mountain area so that they will contribute the maximum volume of usable forest products on a sustained basis. This means: (a) assistance to existing wood-using industries and (b) establishment of new wood-processing plants. Some of the attainments toward which the Madison Laboratory research program is directed are:

   a. To better the existing wood-using industries and develop new secondary wood-using industries in order to create new payrolls for an increasing population.

   b. To establish a wood-laminating plant to serve the needs of the region.

   c. To establish a chemical industry in the region using wood as a raw material.

   d. To assist the pole and post industry so that it will develop in a manner that is compatible with local forest management needs and the existing cedar-pole and other wood-using industries.

   e. To establish a plywood industry in the region integrated with the lumber and fiberboard industry using western larch and other local species.

   f. To assist the existing pulp and paper industry, and encourage the establishment of pulpmills in northern Idaho and western and eastern Montana.

   g. To expand the fiberboard industry to northern Idaho, western Montana, and northeastern Washington.

3. The Forest Utilization Service will undertake the following projects during 1949:

a. Survey kiln-drying facilities and practices in the Northern Rocky Mountain area.

b. Assist the Madison Laboratory in revision of Technical Bulletin No. 835, on the properties and uses of western larch.

c. Make periodic inspection of wood-service-test installations of poles, ties, and fence posts.

d. Arrange for survey of pulp and paper mill possibilities of eastern Montana.

e. Prepare series of research notes for each species tested for pulping properties in recent years, giving highlights of tests.

f. Inspect western larch transmission poles in Pasco, Washington, area to determine degree of checking and spiral-grain distortion.

g. Arrange for feeding experiments of fodder yeast at the Montana State College to determine suitability of this material as a high-protein-content feed for sheep and other livestock.

h. Cooperate with Montana State College, Montana Industrial Development Division, and others in the development of specifications and costs for a wood-molasses plant suitable for Montana conditions.

i. Arrange for additional wood-molasses feeding tests for livestock.

j. Prepare station paper on the influence of diversion of ponderosa pine and larch peeler logs for plywood production on lumber recoveries and net return of a typical sawmilling operation.

k. Prepare research notes by species on the results of studies done to date on veneering properties and plywood-production possibilities.

l. Assist the Anaconda Copper Mining Company, Bonner, Montana, in the development of its new laminating plant for initial production of mine guides.

m. Survey and report on the use of aged sawdust as a soil conditioner in the Bitterroot Valley.

n. Apply results of Middle Western survey of secondary wood-using industries to local situation with expectation of increasing local remanufacture of native woods, especially ponderosa pine.

o. Assist in development of possibilities of a fiberboard plant in the Spokane area.

p. Select and ship to Madison Laboratory second-growth ponderosa pine suitable for transmission poles.

q. Assist Madison Laboratory representative in studies of (1) seasoning and its influence on the results of nonpressure treatment and (2) absorptions of preservatives in open-tank pole treatments.

r. Participate in activities of American Wood-Preservers' Association.

s. Participate in activities of American Standards Association in matters pertaining to the standardization of forest products.

t. Participate in activities of industrial development organizations in connection with problems involving the forest products industries.

u. Continue assistance to Northwest Wood Products Clinic in development of suitable programs.

v. Assist in development of an Inland Empire section of the Forest Products Research Society.

DIVISION OF RANGE RESEARCH

A. Accomplishments in 1948

Artificial Range Reseeding

1. Preparation of a manuscript on species adaptation tests in central Montana was a major project through 1948. This and other project work was delayed somewhat by the detail of Friedrich to Flood Control Survey from August through October.

2. Forage yield from grasses airplane seeded in 1944 on the Henry Creek burn near Plains, Montana, held up well through the fourth growing season. Air-dry yields of reseeded species averaged about 2,100 pounds per acre. This compares with about 3,000 pounds per acre in 1946 when plant food released by the fire was still plentiful. Accumulations of down timber have kept grazing use on the light side during the past two years.

3. Plant development studies conducted at the Antrim Experimental Area in the Bitterroot valley show that fruiting and other developmental stages of many forage grasses tend to occur at approximately the same dates each year regardless of earliness or lateness of spring. Big bluegrass, an early-starting species, reaches the ripe seed stage 5 to 6 weeks earlier than intermediate wheatgrass, a late-starting species. Intermediate wheatgrass holds special promise as a hay grass because it flowers and is ready to cut in early July when good haying weather is more likely to prevail than in June when most other species are ready for haying.

4. Two new studies were established on the Antrim area. One compared two or more strains of each of several promising species, the other tested the adaptation of several new and insufficiently tested species.

5. How each of 7 promising species has performed when seeded in mixture with crested wheatgrass was determined on permanent chart quadrats at the Antrim area. To date results indicate that crested wheatgrass cannot compete successfully with sheep fescue, but will suppress Russian wildrye. Bluestem and intermediate wheatgrasses, meadow brome, big bluegrass, and ladak alfalfa appear compatible with crested wheatgrass.

6. Smooth brome and ladak alfalfa show promise of controlling Wyethia on a protected reseeded area in Eureka Basin, Beaverhead National Forest. A 2-acre Wyethia area was plowed and seeded to smooth brome in the fall of 1946 and broadcast with ladak alfalfa in the spring of 1947. Considerable Wyethia survived the plowing, but the stand of reseeded forage species is adequate to test the possibility of removing and controlling Wyethia by plowing and reseeding. This test is being conducted in cooperation with the Beaverhead National Forest.

7. Fertilizer applications on 4-year-old crested wheatgrass range at the Antrim area increased herbage yields. Early spring applications of 100, 200, and 300 pounds per acre of ammonium sulphate on 4-year-old crested wheatgrass produced air-dry herbage yields, in July, of approximately 2,535, 3,257, and 3,180 pounds per acre, respectively. Without the fertilizer, production averaged only 1,760 pounds. The extra forage cost $12.00, $10.00, and $16.00 per ton, respectively, on the treated areas.

8. Conifer reproduction was satisfactory on skid trail areas successfully reseeded to forage species as well as on skid trail sections not reseeded successfully. Skid trails successfully reseeded to several forage grasses in pure lots after logging in 1943 supported one ponderosa pine seedling per 36 linear feet of skid trail by 1948. Where reseeding was unsuccessful the pine seedlings averaged 1 per 38 feet of skid trail. Including Douglas fir, total tree reproduction averaged 1 seedling per 11 feet of skid trail for the successfully reseeded areas compared with 1 per 14 feet of skid trail where reseeding of grasses was unsuccessful. These data confirm earlier findings on the Blacktail Unit of the Bitterroot National Forest where good stands of ponderosa pine reproduction occurred on reseeded skid trails after a heavy grass cover was established.

9. Reseeding results were demonstrated for stockmen and members of Federal and State conservation agencies. Two organized groups of about 70 men, composed of ranchers, members of Montana State Agricultural College Experiment Station Advisory Council and faculty, and Forest Service personnel from the Lewis and Clark National Forest, inspected the Judith Basin experimental area. A field seminar also was held for 12 Extension Service people at the Antrim experimental area.

Management of Summer Ranges

10. The Vigilante experimental range was stocked for the 12th consecutive year. Lack of control permitted 25% to 30% heavier use than usual. The fall utilization survey was the only vegetative study completed. The two major forage species, Idaho fescue and bluebunch wheatgrass, received 35 and 23 percent use, respectively, on the average over the range unit. These use percentages plus the fact that the unit was definitely grazed beyond capacity indicate that the tentative utilization standards for these two species, 40 and 35 percent respectively, developed on the unit in years past, may be out of line and in need of further consideration.

11. Idaho fescue and other forage grasses decreased but weeds increased sharply the first year after big sagebrush was burned. This test was started on the Whitworth Brothers' ranch adjacent to the Beaverhead National Forest. Outstanding changes one year after burning were: (1) burning reduced the total vegetal cover about half; (2) density of all grasses dropped 50%; (3) weeds increased from 8% to 53% of the total vegetative composition; (4) practically all surface litter was burned; (5) first-year seedlings of big sagebrush were more vigorous (air-dry weight averaged 34 times heavier) on burned than on nearby unburned areas; (6) some evidence of increased wind erosion.

Burning removed the sagebrush and made practically all of the herbage that grew in 1948 available to grazing animals. Before burning only about one-third was available. Benefits to date have not balanced the cost of burning and the resulting range damage. Ultimate results of sagebrush burning without reseeding depend largely on whether the remaining grasses can spread rapidly enough to gain control of the site before the sagebrush seedlings develop into another thick stand.

Management of Short-Grass (Mixed Prairie) Range

12. Three of six manuscripts embracing information basic to good management of northern plains range were advanced toward publication: (1) drought effects on range vegetation and cattle, (2) effects of heavy and conservative stocking on the growth of range calves, and (3) on yearling ewe growth and condition of sheep ranges. Two other proposed publications reached the review stage and a first draft of a comprehensive account of 14 years heavy, medium, and light stocking on range vegetation, soil, and cow-calf production was nearly completed.

Although proposed publications received major attention in 1948, limited field work and further analysis of earlier data were also undertaken.

13. Increased advantage of moderate and light over heavy stocking on range cow-calf production was shown by new analyses of livestock records from the rate of stocking study conducted from 1932 through 1945. No consistent advantage of light over moderate stocking was indicated. Only cows that started and remained throughout the first or second period of the study and their calves were included in these analyses. This gave a critical comparison of stocking rate effects, giving full weight to these effects that might be accumulative. Results reported previously were based on analyses that included all original cows as well as replacement animals.

Wet cows on moderately and lightly stocked range averaged heavier than those on heavily stocked range even though the latter received more supplemental feed during the drought and most winters. Even more important to livestock operators, wet cows under the lighter stocking rates retained more of their summer gains during the more favorable years to carry into the winter season.

Under moderate and light stocking, cows weaned a somewhat larger calf crop, calves weaned heavier, and weaning calf weight prorated to all cows averaged about 50 pounds higher (table 1).

Table 1 - Calf production under heavy, moderate and light stocking. (Only cows continuously in the study from 1932 through 1936 or 1937 through 1945.)

Intensity of Stocking	1933 Through 1936				1938 Through 1945			
	% Crop	Av. Weaning Wt.- Lbs. Steers	Heifers	Per Cow	% Crop	Av. Weaning Wt.-Lbs. Steers	Heifers	Per Cow
Heavy	75	252	244	185	82	410	378	323
Moderate	79	302	292	232	90	437	411	382
Light	78	305	294	238	89	442	408	379

14. Ungrazed heights of key range grasses showed promise as criteria for judging condition of northern plains range. (a) A consistent and marked difference in frequency distribution of grass heights on the heavily and lightly stocked experimental range pastures was shown by further analysis of measurements taken in 1946 after 14 years of controlled grazing. Under light stocking, mature heights of three principal grasses on several different sites all described a normal distribution curve. In contrast, plant heights from similar sites on the heavily stocked ranges, where production had deteriorated, consistently clustered around the modal class forming a peaked distribution with a more limited total range. If further study shows these distinctive patterns to hold under different weather conditions, such deviations from a normal curve should be a valuable indicator of too heavy past use.

(b) In 1948 after 16 years of light stocking, height of bluestem wheatgrass growing in the open was more nearly equal to that of bluestem growing in the protection of pricklypear cactus than was the case on the range pastures stocked heavily. On one site studied, bluestem leafage in the lightly stocked pastures averaged 92 percent as tall in the open as in pricklypear clumps, compared to 74 percent on the heavily

used ranges. This height reduction under heavy use represents reduced productivity and hence poorer range condition. Heavy stocking effects were apparent for bluestem even within pricklypear clumps. On the heavily stocked range, protected plants averaged only 95 percent as tall as those on the lightly stocked range. Thus under heavy stocking, height reduction of plants entirely available to grazing animals was probably somewhat greater than the 18 percent indicated by the former measurements. These results should be further tested and expanded before height relations of protected and available plants can be evaluated an aid in judging condition.

15. The abundance of litter on the soil may also help in estimating trend of northern plains range. Late in 1948, litter cover on the wheatgrass bench site of the heavily stocked experimental pastures averaged 30 percent, as determined by line-point transects, compared to 46 percent for the lightly stocked pastures. On the latter, litter together with vegetation was sufficient to leave less than one-third of the soil exposed to the direct impact of rainfall, while nearly half was so exposed in the heavily stocked pasture.

16. Growth of crested wheatgrass and seasonal gains of 2-year-old steers grazed thereon were sharply curtailed compared to previous years by a dry spring in 1948, even though June and July were unusually wet. Beef production on this 46-acre pasture stocked heavily from April 19 through July 21 averaged only 75 pounds per acre compared to approximately 100 pounds for each of the preceding 7 years. Average daily steer gains were high (3.27 lb.) for the first 56 days, but later fell off sharply compared to previous seasons. After finishing the season on native range, these steers failed by 22 pounds to equal the weight of comparable animals grazed season-long on native grass. Probable reasons for the decline in productivity of this crested wheatgrass pasture include (1) the adverse effect of a dry spring on growth of this cool-weather grass, (2) almost complete defoliation by grasshoppers during early July, and (3) possible deterioration from continued heavy early season grazing.

17. Results of range reseeding and management studies were explained to a large number of stockmen and to college and other agency groups. About 200 visitors in seven organized groups visited the station during the year. Ranchers, new county agents, Montana State College seniors, Interagency Committee members, Veterans' Administration trainees, Indian Service conservationists, and Production Marketing Administration employees were in these groups. Numerous ranchers and other visitors came individually.

Management of Summer Ranges - Northeastern Washington

18. Management and reseeding research on northeastern Washington ranges began during the summer of 1948. To date, major emphasis has been given to becoming familiar with the region and its range problems.

19. Distribution of Klamath weed in six northeastern Washington counties was determined by consulting county and federal land management agencies and making field spot checks. In all, some 57,000 acres of range in these six counties are now infested by this weed. Of this total, over 50,000 acres are in Spokane county alone, mostly north of the Spokane River; Lincoln County has little Klamath weed and that mostly concentrated in the extreme southeast corner. This survey is preliminary to eradication and control studies on Klamath weed infested ranges.

20. An adaptation trial of 24 grasses and forbs was started near Republic, Washington. The newly established nursery is located in a valley used principally for grazing and adjacent to many badly deteriorated range areas. The adaptation test represents an initial step in determining an effective reseeding program for the locality.

B. Plans for 1949

Artificial Range Reseeding

1. The manuscript on results of species adaptation trials in central Montana will be completed in 1949. A shorter paper describing seasonal development of forage grasses in western Montana also is proposed. This material was presented at the January meeting of the American Society of Range Management in Denver.

2. A joint survey to estimate the size of the range reseeding problem and the need for reseeding research on the National Forests of Region One is planned. An important phase of this undertaking will be a 10-day joint field seminar involving representatives of the Range Research and Flood Control Surveys Divisions of the Experiment Station, and Range and Wildlife Management and Land Use Coordination Divisions of the Regional Office. During this time, representative seedings and areas in need of reseeding on the forests will be examined.

3. Many of the recent National Forests plantings will be examined critically and results analyzed to provide possible guides to successful reseeding on sites and under conditions not yet adequately covered by research.

4. Field days and show-me trips will be conducted as opportunities arise. One meeting already is scheduled with the Montana Conservation Committee for July 18, 1949, at the Antrim area.

Management Summer Ranges

5. Reorientation of the Vigilante summer range manuscript prepared by Harris has started with the objective of preparing (1) a professional journal article, (2) a station research note, and (3) a livestock journal article, each of which will report an appropriate phase of range research conducted at Vigilante.

6. A strengthened attack on range forage, soil, and livestock problems vital to the use and management of mountain summer ranges for sustained high production will be initiated at the Vigilante Station this field season. These problems are given high priority by Forest Service regional office personnel, by supervisors or their representative of three National Forests that already have been contacted, and by State and other interested agencies. Definite requests for more research on Montana summer ranges were heard at the recent investigative meeting and have since come from other sources. Such strengthening within the present framework is possible only by shifting one man from Range Management research at Miles City. This can be done without severely penalizing the Miles City program. High priority will be given the following items in the program anticipated for mountain summer ranges:

(a) Restock the Vigilante summer range unit at the usual level in accordance with past procedure.

(b) Compare the present stocking rate and kind of management in operation on adjacent national forest summer ranges with that obtained inside the Vigilante range unit.

(c) Reconsider all existing vegetative studies for possibilities of salvaging useful data or other information pertinent in the management of mountain summer ranges.

(d) Realign all reseeding studies at Vigilante to be of maximum value in forming guides to Central Montana reseeding problems.

(e) Give maximum consideration to urgent range management and reseeding problems and contribute advice and guidance on such problems to the fullest extent possible.

Management of Short-Grass (Mixed Prairie) Range

7. The first draft of a technical manuscript describing the response of cattle and short-grass range to 14 years of heavy, moderate, and light stocking will be completed and submitted for review early in 1949. Preparation of this information as a proposed farmers' bulletin will then be started.

8. The experimental native range pastures will be stocked at established rates. Long-term continuance of the stocking-rate study was strongly recommended by the regional office administrative staff and forest supervisors attending the annual investigative meeting. The value of continuance, it was generally felt, is emphasized by the large acreage of northern Plains range and its importance in the proposed development of the Missouri Basin. The experimental pastures with their background and accumulated value of 17 years' controlled stocking were cited as an invaluable tool with which to increase our knowledge of how man can use the forage and soil resources and at the same time improve and maintain them at a high level consistent with other values. Seventy-two head of purebred two-year-old Hereford cows are available for present and future stocking. These animals are now being grazed on the experimental ranges in a nutrition study conducted by Montana State Agricultural College in cooperation with the Bureau of Animal Industry and the Forest Service.

9. All urgent range-livestock problems of the northern Great Plains region will be considered as to their importance and what might be done by the Forest Service toward their solution, as guidance for future research at Miles City. A preliminary problem analysis is available and will serve as a base in this effort. Additional guidance will be obtained from National Forest administration personnel, stockmen's organizations, individual operators, the Bureau of Animal Industry, and other Federal and State agencies.

10. Established range studies will be continued. Further attention will be given to (1) condition and trend criteria and standards for native range, (2) grazing value of crested wheatgrass reseeded pasture, and (3) recovery rate of very heavily used native range.

Management Summer Ranges - Northeastern Washington

11. A project analysis enumerating and evaluating range problems of northeastern Washington will be prepared. Future research projects will be based on results of this analysis. Certain problems, however, are so outstanding that plans for attacking them need not be delayed until the analysis is complete.

12. Promising methods for rehabilitating range lands infested with Klamath weed will be tested on a field-treatment basis. For this purpose, a 20-acre tract has been made available by cooperators in the study. Initially, an effective method developed by the Washington State Agricultural Experiment Station in small plot trials will be applied. Other methods will be tested later as they prove promising. Cooperators in the study include Washington State Agricultural Experiment Station, Stevens County Commissioners, Stevens County Agricultural Extension Agent, the Colville City Council, and the Colville Forest Supervisor's office.

13. A series of reseeding adaptation trials will be initiated. Tests are planned for low seabland areas of Lincoln County, high mountain summer ranges of Ferry and Stevens Counties, and mountain meadows of intermediate elevation in Ferry, Stevens, and Pend Oreille Counties.

DIVISION OF FOREST MANAGEMENT

A. Accomplishments in 1948

Priest River Research Center

1. A guide for stand improvement work in Region One of the Forest Service was prepared. It will serve as a manual for sale area betterment work following timber sales operations on national forests. It prescribes stand improvement practices by major forest types in the northern Rocky Mountain region. The manuscript is now in the process of final review by National Forest Administration.

2. Cooperation was extended to the University of Idaho and the Division of Forest Pathology in the study of pole blight. A two-day meeting to discuss pole blight was held at the Deception Creek Experimental Forest in early June, 1948. Representatives were present from the University of Idaho School of Forestry, Division of Forest Pathology, Bureau of Entomology and Plant Quarantine, National Forest Administration, and the Experiment Station. A program of study was planned and assignments made to the various agencies. The University of Idaho agreed to concentrate study on symptomatology, rate of progress of the disease in individual trees and in forest stands, and the relationship of soils to the disease. The Division of Forest Pathology took on the job of searching for cause of the disease, especially to determine if it is infectious. National Forest Administration agreed to survey the distribution of the disease and estimate the damage it has caused to date. The Experiment Station agreed to provide what facilities they could for both the University of Idaho and the Division of Forest Pathology to give guidance to both agencies in any way possible and to continue observations on the fertilizing test begun in 1947.

   The Division of Forest Pathology put three men in the field during the summer season. These men headquartered at the Priest River Experimental Forest. The University of Idaho had a 4-man crew in the field working out from the Deception Creek Experimental Forest much of the time. The Station cooperated with both agencies in providing facilities and in acquainting them with the areas of pole blight infection and past history of the disease.

   A fertilizing test set up in 1947, in which pole blighted trees were fertilized with ammonium sulphate and vigoro at two levels of application, was examined but no recovery of the unhealthy trees was observed.

3. Five-year results of tests of partial cuttings in the western white pine type in mature stands are promising. Mortality on the cut plots has been less than half of that occurring on the uncut plots. These results are now in shape for a station release.

4. Study of direct seeding with germinated white pine seeds was initiated. Virgil Moss of the Office of Blister Rust Control has pointed out the possibility of direct seeding with germinated white pine seed on the supposition that rodents do not like germinated seed and that less seed is needed for establishment of a stand. As a further test of this idea, seeds of western white pine were cracked in a machine built by Moss. These were stratified for various lengths of time, germinated, then direct-seeded in spots on a recent burn in the Kaniksu National Forest during May. Stratified, but uncracked, seed were also seeded. Plots of screened and unscreened spots were established using both cracked and uncracked seed. As germination was poor for all treatments, results of the test were not very conclusive.

Results at the end of the first growing season were as follows:

Treatment of seed	Percentage of spots stocked at end of growing season (Percent)
Cracked, stratified, germinated	
screened	25.5
unscreened	4.0
Uncracked, stratified, ungerminated	
screened	19.5
unscreened	5.5

These results indicate that rodents had equal preference for germinated and ungerminated seed and that seed must be protected from rodents by some method, such as screening or poisoning. However, more work apparently is needed to fully test the method.

5. Cooperation was extended to private agencies. Holdings of Potlatch Forests, Inc., were visited and their timber management problems discussed in the field. Preliminary plans were made for setting up cooperative tests of partial cuttings, beginning in 1949.

6. A study of girdling showed that the method is useful and cheaper than felling scattered undesirable trees. A report, prepared for release as a station paper, presents results from two sets of plots on the Deception Creek Experimental Forest. Hemlock and grand fir trees were girdled in 1954 and 1955, and the effects were observed until 1948. Effects of girdling on cone production, mortality, rate of disintegration of trees, and damage to reproduction were studied in detail. Cone production was neither increased nor decreased. Trees died within three to four years after girdling. Needle fall commenced four months after girdling. Disintegration of girdled trees progressed from the finer to the coarser branches. Bark on the main stem began to crack and scale off on the majority of trees five to eight years after girdling. Trees began to break off three years after treatment. Second bole breaks began six to seven years after girdling. Disintegrating trees caused only light damage to the reproduction stand. The report concludes that girdling is not advisable as a method of disposing of unmerchantable defective trees where large numbers of trees per acre are to be killed because of the extreme fire hazard it creates. However, girdling should be useful and cheaper than felling where scattered trees need to be eliminated.

7. Timber sales on the Deception Creek Experimental Forest were resumed with help of the staff of Coeur d'Alene National Forest. Over 100,000 board feet of wind-thrown western white pine were sold at a stumpage price of $28.00 per M. As these trees were badly infested with beetles, it was necessary to remove them from the area to prevent an infestation from developing.

Plans were completed for another sale of three million feet of low-vigor trees, mainly Douglas-fir. Although this timber was advertised in the fall of 1948, no bids were received. It is hoped that this sale can be completed in 1949.

8. Help was given to the Blister Rust Control Office in developing procedures for white pine disease and stocking surveys. The purpose of these surveys is to provide more information on white pine units to aid in unit analyses with respect to blister rust control. The Station provided guides for projecting composition and yield of sapling and pole stands to maturity.

Western Montana Research Center

9. Studies of cut-over areas in western Montana show that Douglas-fir is replacing ponderosa pine, particularly on north slopes. Ponderosa pine is important in the economy of western Montana. Douglas-fir is less desirable both economically and silviculturally

because of its defective condition and relatively poor growth. Replacement of ponderosa pine by Douglas-fir is, therefore, a serious obstacle to future forest management.

The following table, determined in two studies, shows the species composition of the overwood stand before logging as compared to the present dominant young stand.

Species	Extensive study western Montana 1/		Intensive study Lick Creek	
	Overwood stand before logging	Young stand after logging	Overwood stand before logging	Young stand after logging
	Percent	Percent	Percent	Percent
	Northern Aspect			
Ponderosa pine	75	15	90	18
Douglas-fir	25	85	10	82
	Southern Aspect			
Ponderosa pine	84	62	90	56
Douglas-fir	16	38	10	44

1/ Average for 21 widely distributed locations.

The greatest encroachment of Douglas-fir was found on north slopes. Here it became established in greater numbers than pine under the virgin stand prior to logging. Prompt and abundant seeding of Douglas-fir following logging also contributed to its abundance in the young stands. Sufficient pine reproduction to stock the land was generally found on north slopes, but the greater abundance of Douglas-fir in a dominant position precludes the pine from becoming the principal species in the final crop.

On southerly aspects, the proportion of ponderosa pine in the dominant class was more favorable. Nevertheless, there was an increase of Douglas-fir on these aspects as well. The present composition on both aspects is likely to persist unless the Douglas-fir is reduced by stand improvement measures.

A start has been made on the problem of encouraging pine to regenerate more abundantly by initiating a study in cooperation with the Kootenai National Forest. It will test three types of

soil preparation on a going timber sale. Treatments being studied are: (1) prescribed broadcast burn, (2) dozer pile and burn, and (3) hand pile and burn. Seven transects, each containing 100 milacre quadrats, were installed in the treated stands in 1946.

10. More than one-half million board feet of timber were marked, and 44 permanent sample plots were installed preparatory to a second cutting in Lick Creek. This is a cooperative project between the Bitterroot Forest and the Experiment Station. Nearly 40 years have elapsed since the first cut. Studies made in 1946-47 show that it is time for a second cut. The stand presents an unusual opportunity to begin second-cutting-cycle studies immediately.

The purpose of the project is to determine the results of a light second cut, removing a timber volume about equal to the growth since the first cut. Attention will be given to the following items: (1) Responses and growth rates of residual trees, (2) rate and quantity of ingrowth from pole-size trees, (3) mortality, (4) numbers and composition of reproduction in openings created by logging, (5) timber stand improvement, particularly measures designed to restrict Douglas-fir, and (6) logging damage to the young stand.

An area of about 220 acres was selected for the experiment. Average volume is 7200 board feet per acre of ponderosa pine. Present volumes range from as low as 2000 board feet to as high as 15,000 board feet per acre. The study will test second cuts in four different densities of reserve stand.

Timber on the experimental area has been marked with an aim to reserve trees which are likely to grow in volume and quality. Improvement of spacing was another aim. In general, the following kinds of trees were marked to cut: (1) spike-topped and thin-crowned unhealthy trees, (2) lightning-scarred trees, (3) trees with excessive lean, (4) those with visible butt rot, (5) poor quality trees from mature or overmature groups, (6) rough dominants from young groups where better quality subordinates could be released, (7) slow-growing, overmature trees, and (8) all merchantable Douglas-fir. It is expected that the timber will be logged sometime in 1949.

11. A study of ponderosa pine seed production was initiated. Twenty seed traps, 1/4-milacre in size, were placed in a partially cut ponderosa pine stand on the Kootenai National Forest to measure the seed fall. Traps were set out on August 5 and seed counts made on three subsequent dates. The numbers of sound seed per acre which fell are as follows:

Period	Ponderosa pine	Douglas-fir	Western larch
August 8 to Sept. 8	5,000	790	400
Sept. 8 to Oct. 7	64,400	570	1,000
Oct. 7 to Oct. 29	5,600	600	400
	75,000	1,960	1,800

1948 was considered a better-than-average seed year for ponderosa pine. Seed catches shown above are numbers of seed naturally dispersed. They do not account for losses caused by seed-eaters before dispersal, or destruction to unprotected seed after reaching the ground. However, the Station biologist is cooperating in an investigation of the quantities of seed taken by animals after dispersal.

12. A review of existing silvicultural information on the larch-Douglasfir type was made and published. The purpose was to summarize available information both for forest managers and as a preliminary step in initiating research in the larch-Douglasfir type in western Montana.

The larch-fir type was studied considerably from 1912 to 1925. In that period, the cut of larch and Douglas-fir in Montana amounted to about half of the total lumber production in the State. After 1931, however, total cuts of these species fell
15. off and interest in silvicultural and forest management practices waned. In recent years, however, larch and Douglas-fir have regained their former importance due to increased demands for lumber.

The report points out that there was a considerable degree of consistency in the early recommendations. General agreement was found on the following major points:

1. Western larch is the more desirable species to maintain in the type.

2. Larch is very intolerant of shade. Its more shade-tolerant associates tend to succeed it.

3. Stands are mature at around 120 to 150 years.

4. Clear-cutting with seed trees, or heavy cutting with reservation of not to exceed 50 percent of the volume including the smaller Douglas-fir and associated tree species, are the most common recommendations for mature and overmature stands.

5. Improvement cuttings or commercial thinnings are suggested for immature stands.

An apparent weakness in the early recommendations lies in the lack of measures advocated to cope with species which tend to replace larch. The heavy cuttings recommended were clearly intended to establish even-aged larch reproduction. But in view of the natural tendency for larch to be replaced by other species, provision for holding heavy residual stands of other species for long periods was inconsistent. The big problem, then as now, is: What to do with the advance growth of Douglas-fir and other species, especially trees that are approaching merchantable size.

The report concludes that if we are going to grow larch with a fair degree of assurance, it will be necessary, in addition to providing for a larch seed supply, to (1) greatly curtail seed production by its competitors, (2) create favorable seedbed conditions, (3) make room for young larch to thrive, (4) clean and thin young larch stands as needed, and (5) at times, reforest by planting or direct seeding if natural reproduction fails.

13. A preliminary vigor classification for western larch and Douglas-fir in the larch-Douglasfir type was developed. External characteristics were used to describe three classes of vigor, namely: A - good, B - fair, and C - poor. Table 1 summarizes the classification.

Six hundred and eighty-five reserve trees, 10 inches d.b.h. and larger at time of logging, were examined on cut-over areas throughout western Montana. These were grouped into the three vigor classes described. Trees in the best vigor group (Class A) grew at a rate about one and one-half times faster than the average, the medium vigor group (Class B) grew slightly less than average, and the poorest group (Class C) grew at about one-half the average rate.

The classification was constructed for trees 10 inches d.b.h. and larger, 100 years of age and older, in western Montana. Its utility in other localities and types has not been determined. It is believed that this preliminary vigor classification will be found useful by tree markers and especially for training inexperienced markers.

Table 1.—Characteristics for classifying the vigor of western larch and Douglas-fir residual trees in larch-fir type in western Montana

Characters	VIGOR CLASS		
	A (Good vigor)	B (Fair vigor)	C (Poor vigor)
. Position of crown	Usually dominant or codominant, occasionally intermediate.	Ordinarily codominant and intermediate, rarely dominant.	Usually intermediate or suppressed, occasionally codominant and rarely dominant
. Length of the crown	Crown length 40 percent of the total height or longer. Unusually wide crown may be shorter but not less than 30 percent.	Crown length usually from 20 to 40 percent of total height. In narrow crowns greater length may be allowed.	Crown length usually will not exceed 20 percent of total height. In extremely narrow crowns greater length may be allowed, but not to exceed 50 percent.
. Width of the crown	Crown width average or wider.	Crown usually average width. May be narrow and long or wide and short.	Crown usually narrow or occasionally of average width.
. Shape of the crown	Tip usually pointed or round, never flat or spike topped.	Tip usually round, occasionally pointed, and rarely flat topped.	Tip usually flat or spike top, rarely rounded.
. Branching and foliage	Dead branches in the crown rare, branches and foliage moderately dense or better. Branches in upper half of crown usually strongly upturned and no drooping branches.	Occasional dead twigs present, usually no dead branches in the crown. Branches and foliage of moderate density. Occasionally large crowns of extremely open density. Usually the upper branches either upturned or horizontal, with drooping branches in the lower half of crown.	Dead twigs and branches showing through the crown. Often branches drooping to the tip. In western larch 1/ branches short and stout throughout the length of the crown.
5. Bark	Western larch - Bark is usually dark in color and ridged or only slightly scaly with deep fissures between scales. Bark appears rough. These bark characters apply to western larch only. Do not use on Douglas-fir.	Western larch - Bark is usually dark around base of tree, becoming scaly above. Plates not well defined, but bark appears relatively smooth. These bark characters apply to western larch only. Do not use on Douglas-fir.	Western larch 2/ - Bark usually light in color with well-defined large, smooth bark plates and very shallow fissures between plates. Bark appears very smooth. These bark characters apply to western larch only. Do not use on Douglas-fir.
	Douglas-fir Bark usually has broad, corky ridges at the base, with light brown new bark prominently exposed in the fissures, becoming uniformly and finely ridged and dark above. The upper quarter or more of the bole usually has smooth or slightly checked light grey bark.	Douglas-fir Bark has corky ridges at the base of the tree, becoming uniformly and finely ridged above. New light brown bark not as prominent as in A vigor and usually extending only part way up the butt log. Dark, rough bark extends at least three quarters or more up the full length of the bole.	Douglas-fir Bark rarely has the light brown new bark exposed in the fissures. Dark bark usually extends to the tip. Frequently the entire bole has dark, finely ridged bark.
7. Disease	No mistletoe infection.	Rarely trees with light mistletoe infection.	Trees with visible indications of moderate to heavy mistletoe infection should be placed in this vigor class.

1/ Frequently in western larch, short, stout branches near the tip give it the appearance of being pointed. This should not be confused with a pointed growing tip which usually has numerous thin branches and is normally obtusely pointed.

2/ Trees with this type of bark are overmature and usually growing slowly. They should be dropped one class below that in which they would otherwise classify. Thus, if a tree qualifies for A vigor, but possesses the light, smooth bark with well-defined plates and shallow fissures, it should be dropped to the B vigor class.

14. <u>A study of selectively cut larch-Douglasfir stands showed that larch is being replaced by more shade-tolerant species.</u> Three factors which affect the growth and response of individual trees were found to be important. These are: (1) vigor, (2) reserve stand volume (competition), and (3) species. Trees were classified by the vigor classification developed for larch and Douglas-fir.

Maximum growth of individual trees occurred in the lightest reserve stands. Diameter growth rates decreased rapidly with increasing volume of reserve up to 5,000 board feet per acre, after which it tended to level off. The trend described was the same for trees in all vigor classes. "C" vigor trees were an exception in that response was negative, but the trend of growth paralleled that of the "A" and "B" vigor trees.

Douglas-fir made faster diameter growth, both before and after logging, than did western larch. However, the response to release, or the acceleration of growth, was greater in larch trees. The best vigor larch, under maximum release from competition, grew at good rates (up to 1.1 inches diameter per decade). Under similar conditions, Douglas-fir grew practically the same. Best vigor larch, under greater competition, grew somewhat more slowly than Douglas-fir. Trees of both species in the three different vigor classes exhibited significantly different rates of growth.

Class A vigor reserve trees in very light residual stands produce the maximum acceleration of diameter growth after logging. However, in order to get high per-acre growth, ample growing stock must be left. It may be better to leave more trees per acre and expect less than maximum response by individual trees.

A special, intensive study was made in a 59-year-old Forest Service cutting in larch-fir type near Seeley Lake on the Lolo National Forest. The original stand before cutting contained from 24,000 to 29,000 board feet per acre in trees 10 inches d.b.h. and larger. It was composed principally of western larch, Douglas-fir, and lodgepole pine, with minor quantities of ponderosa pine, grand fir, alpine fir, and Engelmann spruce. Marking was aimed to increase growth of larch and ponderosa pine in the residual stand. Western larch made up 52 percent of the volume in the original stand; 58 percent of the volume in the reserve stand.

The study indicates that selective cutting in the larch-fir type tends to favor the more shade-tolerant but less desirable

species, particularly Douglas-fir. The following table shows annual growth and mortality by four reserve stand classes and species groups for the 39-year period.

Reserve stand class	Western larch and lodgepole pine				Other species				Total net annual growth all species
	Ingrowth	Growth on residuals	Mortality	Total net annual growth	Ingrowth	Growth on residuals	Mortality	Total net annual growth	
Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.
1200	17	4	2	19	47	22	1	68	87
4000	12	29	5	36	37	43	12	67	106
5800	7	47	15	40	25	37	2	60	100
11000	0	66	16	50	30	32	12	50	100

Larch was poorly represented in the ingrowth because of its relative intolerance. The less desirable but more shade-tolerant species, such as Douglas-fir, Engelmann spruce, and alpine fir, dominated the pole stands which developed under the virgin stand. Release due to logging then brought an upward surge in the growth and, consequently, large amounts of ingrowth of these species.

Larch increment for the 39-year period was exceeded by the combined volume gains of the other species in all but the heaviest reserve stand class. Hence, the relatively slow growth of the old overmature larch residuals was largely offset by the faster growth of the younger residual trees and ingrowth of the other species.

Five-year periodic growth did not show any rapid increase in average growth rates due to logging release. While trees of good vigor responded to release, many trees with fair and poor vigor did not.

Mortality was heaviest in lodgepole pine due to a mountain pine beetle (Dendroctonus monticolae) attack in the late twenties and early thirties.

This study re-emphasizes the natural tendency for tolerant species, in the absence of fire, to increase and for larch to decline in abundance. Hence, the creation of conditions

favorable for establishment and growth of larch are necessary to maintain or increase its production in the larch-fir type.

15. Plans have been made and work started on a cutting experiment in a larch-fir stand on Blue Mountain in the Kootenai National Forest. This is a cooperative project between the Kootenai National Forest, J. Neils Lumber Company, and the Experiment Station.

Blue Mountain now supports a relatively good stand of mature western larch. A large portion of the trees in the stand are of good vigor and can be expected to show favorable response to logging release. A dense growth of grand fir, alpine fir, and Engelmann spruce makes up the understory. Hence, the natural tendency in this stand will be replacement of larch by these more tolerant species.

The main problem is how to destroy the understory and obtain larch reproduction. Three types of soil preparation methods are being tested in combination with three different cutting methods. There is considerable evidence that larch will reproduce on exposed mineral soil. Slash disposal methods which expose the mineral soil will provide favorable seedbed conditions. Scarification of the soil surface with the slash buncher and broadcast burning appear to be the most promising methods. Therefore, within each cutting area the following methods will be tested:

17. (1) Hand pile and burn slash (this will serve as a check).

(2) Pile slash with buncher and burn.

(3) Prescribed broadcast burn.

A second problem is how to cut the timber to give the highest growth on the reserve stand. Types of cutting to be tested are:

(1) Shelterwood preparatory cut (selection of trees to be cut based mainly upon vigor).

(2) Seed tree cut (approximately five seed trees per acre).

(5) Economic selective cut (75 percent of larch trees 20 inches d.b.h. and over and 20 percent of the larch from 14 to 18 inches d.b.h. and over are to be cut).

16. A test of lodgepole pine X jack pine hybrid has been started. Hybrid seed, natural seed from the lodgepole pine parent, and seed from Wisconsin jack pine, were supplied by the California Forest and Range Experiment Station. These, along with lodgepole pine seed from local sources and jack pine seed from Minnesota, were sown at the Savenac Nursery on May 14, 1948

Although it is too early to determine results, slight differences in first-year height growth were noted. Total heights of random samples of 15 seedlings in each lot were measured on September 7, 1948. Average heights are shown below:

Lot	Average height (Inches)
Lodgepole pine X jack pine	1.7
Lodgepole - California (hybrid seed parent)	1.2
Lodgepole pine - Missoula	1.0
Lodgepole pine - Moser Creek (Gallatin National Forest, Montana)	1.2
Jack pine - Wisconsin	1.7
Jack pine - Minnesota (Chippewa N. F.)	1.5

17. Tests of three Christmas tree cultural practices were initiated. The Christmas tree industry in western Montana supplies one-seventh of the Nation's Christmas trees and brings a million dollars annually to the State. For several years there has been a need for factual information regarding cultural and management practices. Christmas tree growing stock on many private holdings seems to be deteriorating, largely due to unplanned management and lack of proper cultural practices.

Pruning to increase crown density is one kind of measure which is being tested. Five pruning methods are under investigation. They are:

1. Removing the lower one-half of the green crown.

2. Removing the lower two-thirds of the green crown.

3. Removing one-half of the green crown from the middle.

4. Removing the live branches from one side of the bole for two-thirds of the length of the crown and peeling off a one-inch wide strip of bark on that side.

5. Shearing the terminal buds from the leader and side branches.

One tree in each of six pairs of trees was pruned one way. A total of 30 pairs is involved for all five methods. The unpruned tree in each pair is a check tree. All trees in the experiment were graded when they were located. Any improvement between pruned and check trees will be determined in subsequent gradings.

A second practice under study is stump culture. Side branches on stumps often turn up to produce another tree from the old root system. Adventitious growth buds on the stump can produce the same result. In the study of stump culture, pairing of trees is the method used. One of each pair of stumps is treated to favor a branch turn-up, the other is aimed for adventitious bud growth. In a total of 24 pairs of stumps, 6 pairs were treated at the time of the Christmas tree harvest, 6 pairs will be treated one year later, another 6 pairs will be treated two years after cutting, and a third 6 pairs will be treated three years after the trees were cut.

Thicket thinning is the third cultural practice being tested. What severity of thinning produces the most trees of the highest quality? To answer that question, three 1/100th-acre circular plots were established in a uniform thicket. Light, moderate, and heavy thinning was performed. Subsequent grading and counting of the Christmas trees produced on each plot should provide the answer to the question.

The above three experiments were installed in the Eureka and Kalispell production areas.

18. A report was issued to explain and suggest methods for combating extensive damage to the needles of Douglas-fir Christmas trees in the northern Rocky Mountains. The Station cooperated with Dr. Thomas W. Childs, Pathologist, U. S. Department of Agriculture, Bureau of Plant Industry, Soils, and Agricultural Engineering; Dr. Charles W. Waters, Montana State University; Phillip C. Johnson, Entomologist, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine; and L. S. Matthews, Farm Forester, U. S. Department of Agriculture, Soil Conservation Service, in a short study and determination of cause of the disease and other factors which damaged Christmas trees in 1947. The damage appears to have been caused by a combination of several factors, including a needle disease, insects, a spider mite, and premature cutting. Prevention of damage by the needle disease, insects, and spider mite is not economically feasible under forest conditions. A report, Research Note No. 65, was issued in July, 1948, to assist tree owners and forest managers in identifying the causal organisms. This enabled the operators to make preliminary surveys to locate areas where damage was so severe as to make cutting inadvisable in 1948.

Spokane Research Center

19. A study of sample tree measurement on timber sales was begun. Measuring tree volumes at time of marking has replaced log scaling on many timber sales in Region One. In the hope that statistical sampling methods could reduce volume measuring costs, a detailed study was started. The study also includes an analysis of related problems which affect accuracy and cost of estimating volumes on timber sales - use of volume tables, check scaling methods, time, output per man-day, etc.

Methods for the study were set up by Roy Chapman, statistician in the Washington Office. Samples were taken from tree measurement scale books on the Colville, Kaniksu, Kootenai, Cabinet, Flathead, Lolo, Bitterroot, and Coeur d'Alene National Forests. The samples were taken at various sampling rates. The sales represented a wide variety of conditions. Twenty-four samples of ponderosa pine sales, 22 of Douglas-fir, 21 of larch, 8 of white pine, and 8 of spruce were collected and analyzed. In addition, 41 samples of check scale data were collected.

Collection of data and much of the analysis had been completed by the end of the year. A preliminary report will be issued early in 1949. Substantial assistance in conduct of the study was furnished by National Forest Administration.

B. Plans for 1949

Priest River Research Center

1. Preparation of two reports on results of partial cutting tests is the first job to be undertaken. One report will summarize five-year results on mortality and growth following partial cutting in mature stands. The second will be a cooperative report by the Station and the Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine on a tree vigor classification for use in partial cuttings in the western white pine type.

2. Tests of partial cutting will be extended into the Clearwater region. It is planned to test partial cutting in a young stand near Pierce in cooperation with Potlatch Forests, Inc., and National Forest Administration. In addition, it is planned to establish permanent plots in partial cuttings already made on the Clearwater National Forest to obtain information on mortality and growth following such cuttings.

3. Records of stand development and yield will be analyzed and reported. A start is being made in compiling and analyzing 20-year records of many growth plots in the western white pine type. These records are proving of value in determining growth trends in immature white pine stands. Information from these records on stand development and yield will help to guide the stocking and disease surveys now being made for the determination of priorities of blister rust control on white pine units. This will permit an actual check on normal yield tables as contrasted with previous methods of compiling yield tables by measuring plots in various even-aged stands.

4. Station Paper No. 3, "Blister Rust Control in the Management of White Pine" will be revised to bring it up to date. First issued in 1940, this report has served a very useful purpose. The Station continues to receive a large number of requests, but the supply is exhausted. To meet the continuing need for the publication and to incorporate new material, it will be revised as a cooperative job between the Office of Blister Rust Control, Bureau of Entomology and Plant Quarantine; Montana State University; and the Station.

5. Participation in research on pole blight will be continued. The Station will continue to work with the University of Idaho and the Division of Forest Pathology on the study of pole blight. Also, work will be started on cutting practices that

may serve to control the disease. It is planned to get experiments started on three national forests. This job will require very extensive assistance from national forest people involved. The Station plans to hold a pole blight school this spring to teach national forest personnel and state and private foresters how to recognize the disease.

6. A summary will be prepared of what is known to date about more advanced methods of direct seeding. We are cooperating with Virgil Moss of the Office of Blister Rust Control on this. Additional field sowing also will be undertaken.

7. A report will be prepared on a tree poisoning test which was begun at Deception Creek three years ago.

Western Montana Research Center

8. Two station papers will be prepared for predicting growth after logging in cut-over ponderosa pine and larch-Douglasfir stands. These reports will be based upon data obtained from cut-over area studies started in 1946 in western Montana. Analysis has been completed.

The reports will enable forest managers to make estimates of growth to several different levels of refinement. In addition, management practices will be suggested based upon the findings in the study.

9. A larch-Douglasfir regeneration experiment will be started on Coram Experimental Forest. It will be installed on areas cut during the war. Two types of treatment will be tried; namely, prescribed burning and soil scarification. The Station is purchasing an Athens disc for use in soil scarification. In addition, if time permits, a cutting experiment will be planned and installed to study methods of cutting in the larch-fir type.

10. Work will be continued on the Lick Creek second cut study. Plots which have been installed will be re-examined after logging is completed. Plans will be made for timber stand improvement experiments to be initiated following logging. Permanent sample plots will be installed in several types of treatments to be tested. Logging damage and woods waste studies are proposed on this area in cooperation with Forest Survey. The effect of light cutting on logging costs will be studied.

11. Installation of plots will be completed on the Blue Mountain experimental cuttings in the Kootenai National Forest. It is expected that the J. Neils Lumber Company will commence logging on this area in the spring of 1949, as soon as road conditions permit. Following cutting, plots will be examined for effect of logging on residual trees and advance reproduction. When seedbed preparation has been completed, the plots will be re-examined.

12. Additional Christmas tree cultural practice tests will be installed. These will replicate existing plots in Lincoln and Flathead counties. The new plots will be located in the Plains-Thompson Falls area, Missoula district and Darby area. In addition to these experiments, and if time permits, an over-all management-economics, 40- to 80-acre plot will be installed close to Missoula to provide cost and returns figures under ideal management. Also, basic studies such as the following will be started at Missoula only:

1. Large Douglas-firs, when felled but not severed from the stump, will produce a row of trees along the bole. Can this method be used to advantage?

2. At what height are stumps best cut for stump culture?

3. Are there age or size limits for good stump culture?

An investigation into the management aspects of lessening Douglas-fir blight and the best method of handling cut trees from blighted stands is planned.

13. Reproduction transects in the ponderosa pine regeneration study near Warland on the Kootenai National Forest will be re-examined in the fall of 1949.

14. The ponderosa pine seed production study which was started in a cut-over stand at Warland on the Kootenai National Forest will be continued. Traps will be emptied and contents recorded early in the spring. Thereafter, monthly observations will be made until the next seed crop is ready. During the fall of 1949, more frequent observations will be made.

15. Hybrid seedlings of lodgepole X jack pine which were started at Savenac Nursery in 1948 will be transplanted this year. Observations of growth and survival will be continued periodically through the growing season.

16. Assistance will be given the Cabinet National Forest in the design and establishment of a series of permanent growth plots in young larch stands. It is planned that the forest will use the data obtained for management plan purposes.

17. The Division of Engineering has requested assistance from the Station in design of an experiment to test the effectiveness of 2,4,5-T in controlling roadside vegetation. Results of such an experiment may be applicable to planting site preparation.

18. Members of the Division will continue to cooperate with the pathologists and entomologists on observations of the Christmas tree blight and other tree diseases and insects.

19. Cooperation will be given the Station biologist on a study of porcupine damage in ponderosa pine stands.

Spokane Research Center

20. A report will be prepared on the results of the study of sample tree measurement. This report will summarize the results of our study as a guide for National Forest Administration. The report will then be shortened for publication as a station release or as a Journal article.

21. A problem analysis for northeast Washington will be started.

22. Management of second-growth stands, an outstanding need in northeast Washington, will be studied. This problem is more acute than the problem of management of old-growth stands. There is need for assembling information on growth of young stands. These data, and perhaps a few temporary plots through the area to establish concrete evidence on growth, will be used to point out the value of holding young stands for the future. In many stands, no special treatment or cutting will be needed. The stands merely need protection from cutting and fire. Premature clear cutting for such crops as fuelwood in young stands should be discouraged.

25. Permanent sample plots to test certain cutting practices, especially different intensities and types of thinning, will be installed, if possible. It would be desirable to work in cooperation with the Soil Conservation Service on demonstration plots on farm woodlots. There are two problems of management - one on farm woodlots and the other on larger ownerships. On these demonstration plots, the best methods available will be used to show how to manage stands to pay as they go and at the same time to build up the growing stock. The main purpose of these plots will be to demonstrate the most practical methods.

24. The Spokane Research Center plans to establish an experimental forest to demonstrate cutting practices on a larger scale than on sample plots. Records will be kept of costs, products sold, and other factors important to management. It is planned to find suitable privately-owned land on which to establish this experimental forest in the hopes that the results will be more useful to private owners than if the experimental area is situated on national forest land.

Central Montana

25. Examine reproduction transects in Hyalite Creek cuttings on the Gallatin National Forest.

26. Confer with Eaton, Jansson, and possibly others, about administrative studies which can be installed on Douglas-fir cuttings.

27. The Division of Forest Management Research will cooperate with the Region and other Station divisions to study the influence of slash disposal in lodgepole pine clear cuttings, upon: (1) regeneration of trees, (2) fuel type, (3) soil erosion, (4) snow storage and melt, and (5) grazing. Since the Station has no funds for conducting forest management research in central Montana, carrying out the project will depend upon cooperative assistance from the Region.

(No page 52)

DIVISION OF FIRE RESEARCH

A. Accomplishments in 1948

1. During 1948 fire control engineering research entered the most aggressive and productive phase of the last ten years. The problem is to evolve a design for fire control systems that will capitalize more fully on new knowledge of fire behavior in the northern Rocky Mountain forests and new equipment and techniques available to the field forces. The specific objective is to determine the principles, methods, and techniques of planning adequate fire control at least possible cost.

Our preliminary efforts have been devoted entirely to fact finding. This has included an analysis of 22,500 Forest Service fire reports, a job that is now 90 percent complete. During 1948 over 12,000 additional reports of two national parks, seven Indian Reservations, seven fire protection associations, and three state forestry departments were analyzed. This latter undertaking has made it possible to determine the total fire load for the region and subsequently to study over-all fire control requirements in the protection of 53,000,000 acres of forest and range lands. Whole-hearted cooperation from a dozen fire protection agencies has made this project of far greater value in developing a broad prospectus of the fire control problems in the entire region.

Some of the truths coming from this analysis might be labeled as proving the obvious. Others shed new light on the basic problem of designing adequate fire control at least cost. The objective has been to get all the basic facts obtainable whether they be obvious or obscure.

The first job has been determining when and where fires occur. The annual average is 2600 fires per year. On the west side of the Continental Divide this is an average of 75 fires per million acres, while on the east side it is 15 fires per million. During peak-load periods on the western forests the number of fires per million acres is ten times greater than the annual average. Peak loads occur later in the season on the eastern forests than on the western forests. Likewise, the peak man-caused fire loads occur later in the season than the lightning fire loads. The heaviest fire occurrence is on the cut-over lands protected by the private associations.

Major efforts are being devoted to a study of fuels and their effect on the design of fire control systems. Several thousand specially selected fires are being used to determine rate of spread by timber type and fuel type. In its incomplete stage this phase of the project has already shown that fires in the more dangerous fuels spread faster than previously believed. Likewise, it has shown that northern Rocky Mountain grass types spread nearly ten times faster than the classifications given them in the fuel type mapping work done in 1934 to 1937.

The fuel studies have also made it possible to analyse the burned area situation in each major timber type. For the first time since forest survey statistics have been available in this region, a compilation was made showing the timber type acreages in the national forests. During the period 1931 through 1945 the average annual area burned in the western white pine type was .146 percent of the area protected. Ponderosa pine was burned at about twice this rate. All types were burned at an average annual rate greater than one-tenth of one percent. Exclusive of brush and grass, the highest percentage of burned area came in the grand fir and Douglas-fir types. The lowest percentage of burned area occurred in the fir-larch type.

Other major phases of the project include analysis of the detection, communication, and transportation systems and a comprehensive evaluation of control action on fires that have occurred over a 15-year period. These studies have enabled us to chart the efficiency of our lookouts on the basis of detection time and percent of fires covered. They have shown how far the fires are from roads, how travel time has changed, and what percent of fires are reached by foot, horse, or mechanized transportation methods. In the field of control action we have determined those relatively simple but basically important facts such as who makes the initial attack, strength of force requirements, line production, etc. In addition all Class E fires have been isolated for a special analysis of control action.

Some of the results coming from the analysis of fire control action appear to be of major significance. Fifty-four percent of the fires are being discovered by lookouts at a cost of approximately one thousand dollars per fire. Eighteen percent of the fires have an initial attack time of over 6 hours. During the period 1931-1939 the average fire was 3½ miles from the nearest road. During the period 1940-1945 the average had been reduced to 2½ miles. The average fire in this region requires 62 man-hours of work to control. This figure varies from 46 man-hours in the fir-larch type to 230 man-hours in the cedar-hemlock type. Five percent of all fires reach Class C or larger size, but 9 percent of the fires on cutover lands reach these sizes. Likewise, a greater number of man-hours are required to control fires on cutover lands than in old burns or green forests. Southwest slopes are the greatest breeders of oversize fires.

The major effort to date has been devoted to documenting the general nature of fire behavior and control in the northern Rocky Mountains. This initial phase is providing the material needed to determine principles and techniques of fire control engineering. From here we can build improved fire control.

3. The relationship of fire control to an expanded watershed conservation program received greater attention during the year. The devastating Columbia River flood of 1948 focused new interest on the condition of the high mountain watersheds. Fire research assisted a special flood control survey board in determining the causes of this disaster. The board concluded that unusual meteorological conditions were the basic cause. However, it also concluded that fire was by all odds the most important single factor in altering the ability of watersheds to retard the run-off. During the flood it was repeatedly observed that snow cover remained longer on unburned than on burned watersheds.

The fire control engineering project has revealed many facts regarding the watershed protection problem. In the northern Rocky Mountains 48 percent of the fires occur at elevations of over 5000 feet. These are watershed fires. Virtually all of the commercial forests where harvesting operations are under way and probably 60 percent of the land area are below 5000 feet. Examination of the burned area in the various timber types gives further emphasis to the magnitude of the fire control job in areas chiefly valuable for watershed protection. In each of the grand fir, Douglas-fir, spruce, and subalpine types the annual percent burned averages higher than in the commercially valuable white pine type. A continuation of present trends will add 280,000 acres of burned area in the subalpine type alone in the upper Columbia Basin during the next half century. This poses a serious watershed protection problem because of the very slow recovery of subalpine types after fires. It suggests the need for further study of burned area objectives in the noncommercial timber types.

Attention was also given to fire control in the upper Missouri Basin. This included a study of the fire problem in the high mountain watersheds of eight national forests and one national park lying west of the Continental Divide in Montana and northern Wyoming. The surprising fact revealed by this study is that more area has been burned since 1934 in the upper Missouri Basin than in the upper Columbia where the fire load is greater and the fuels heavier.

A preliminary report, "Fire Control Planning in the Upper Missouri Basin," was prepared for flood control survey use in the development of the Department of Agriculture Missouri Basin program. This report emphasizes the highly variable conditions in the high mountain watersheds of the Missouri and the need for great flexibility in fire control organizations to meet occasional critical burning periods and to hold down costs during easy periods.

4. The possibilities of dry-icing clouds to make rain and to stop lightning were investigated in 1948. Widespread interest in rainmaking together with a resolution by the Western Forestry and

Conservation Association resulted in Gisborne's calling on Dr. Vincent J. Schaefer, Research Chemist, at the General Electric Research Laboratories at Schenectady, New York. Dr. Schaefer is the originator of the dry-ice method of cloud seeding.

From Schaefer it was learned that several other agencies are testing and developing numerous materials and methods of seeding clouds to make rain. Consequently, there is as yet no justification in the Forest Service entering this expensive and controversial field. Arrangements were made to receive all reports issued by both General Electric and the Weather Bureau-Navy cooperative project at Wilmington, Ohio.

However, when Dr. Schaefer learned about the great number of lightning fires in the northern Rocky Mountain and other regions, he expressed the opinion that cloud seeding might be done in such a way as to reduce or even eliminate lightning from the orographic-cumulus type of cloud. This is one of the most prolific lightning producers. Systematic tests of this possibility have never been made. Furthermore, such work would be within our legally authorized field of fire prevention.

Systematic tests of lightning prevention will require the use of check clouds, similar to the check plots used in silviculture and other research. The Priest River area on the Kaniksu Forest normally produces three separate orographic-cumulus clouds: (1) over the North Baldy Ridge, (2) over Hoodoo Mountain, and (3) over the Looking Glass Lookout. One of these could be seeded and the other one or two observed as checks.

Dr. Schaefer was interested in this possibility and spent three weeks at our Priest River station in late July and early August. The Regional Office of Fire Control prepared a C-47 plane with oxygen to permit topping the clouds. Schaefer was ready to take lapse-time colored movies of both the treated and untreated clouds, and to direct the seeding by radio from Looking Glass Lookout. Lightning-producing clouds originated over each of the three "breeding spots" but each time they spread out and fused rather than remaining separate as they normally do. This was probably caused by whatever abnormal weather controls caused the 1948 summer to be the wettest on record. Consequently, no seeding was done in 1948. A few tests are planned for 1949.

Dr. Schaefer also brought with him and loaned to us a recording micro-ammeter. He installed this on our 150-foot steel meteorological tower near the Priest River headquarters. This instrument records the flow of electric current from air to earth and earth to air during a lightning storm. It responded to storms up to 15 or more miles away. It showed marked deviations in both amperage and the sign of the current, with abrupt deflections of the pen

for each lightning flash in the clouds or strike to ground. At least two genera of deflections, with two or more species in each genus, were charted during two months' operation of this instrument.

The significance of these deflections is not yet known even though several storms were watched by observers on top of the tower, and notes made on the chart to show whether the cause of the pen deflection was a strike or a flash and whether near or far. Interpretation of this basic knowledge appears to be similar to the status of knowledge of electrocardiograph pen deflections some 25 years ago when the electrocardiograph was first invented. It is obvious, however, that use of this instrument will permit, for the first time, the rating of the intensity or violence, and perhaps the fire menace, in each storm passing within range of the instrument. This would be very useful information in forest fire control. Operation of this instrument will be continued in 1949.

Dr. Schaefer gave the station a detailed report of his observations and recommendations. It is being issued as Station Paper No. 19.

This work in lightning prevention is our second research project in Prevention. The first was our work in 1930 and 1931 in testingthe Cyclone Spark Arrester on railroad locomotives. Those tests demonstrated the superiority of the Cyclone Arrester over the Master-Mechanic Front End, and resulted in a marked reduction in railroad fires not only in this region but in many other parts of the country.

5. Streamflow and snow course measurement work, carried for the past 12 years by the Division of Fire Research, was transferred in November 1948 to the new station Division of Flood Control Surveys. More than 15 years ago the close interrelations of weather, fire danger, and streamflow had become obvious. The effect of winter snow depth and water content on fuel moistures during the following fire season, the influence of full-flowing streams versus dry ones on fire behavior and fire fighting, and many other factors were clearly evident. Consequently, our Division of Fire Research commenced snow surveys, springflow and streamflow measurements, and even sponsored some thinned and clear-cut strips to test effects on snow accumulation at high elevations.

One result was the accumulation of the only record of streamflow for a true "Little Waters" available for any part of this region, and possibly the entire Northwest. These data were of major significance in determining the causes of the 1948 floods. They showed not only that the forested watersheds released their water more gradually, but also that a series of abnormally warm nights was the major cause of accelerated flow from the forested drainages.

With the institution of our new Division of Flood Control Surveys, and its establishment of detailed studies at Priest River, the Division of Fire Research has now been relieved of all of this work. Fire Research will continue, however, to be responsible for the year-round operation of the daily meteorological work done at Priest River as a "Cooperative Weather Station" reporting to the U. S. Weather Bureau.

6. Cooperation of the School of Forestry, Montana State University, enabled research to be initiated on aerial detection. A graduate student majoring in fire control, Mr. A. L. Haines, has selected one important phase of the aerial detection problem for his research project and thesis. He is investigating and will prepare a thesis on methods of planning and mapping proposed aerial detection routes. The Division of Fire Research and the Regional Office are cooperating with Mr. Haines in this worthwhile project.

One of the many problems in aerial detection is how to select the patrol route that will provide the maximum coverage per hour of flying time. This is similar to the ground detection problem of selecting the best points for the location of lookout stations. In the latter case the preparation of seen-area maps showing the area covered from proposed sites has been long established as the most practical method. The investigations of aerial seen-area mapping are proceeding along similar lines. The problem resolves itself to selecting the routes where detection coverage is needed and then testing these proposed routes and different flight elevations through the preparation of seen-area maps showing the area visible to the aircraft observer during each flight.

7. Further field tests of aerial bombing of forest fires were not made during 1948. The U. S. Air Force was not in a position to furnish needed aircraft and personnel to permit continuation of this promising work. Continuance of the project in the future rests upon the development of an effective working agreement between the U. S. Air Force and the Forest Service.

The field tests completed in 1947 showed that forest fires can be retarded, though not completely controlled, by aerial bombing. Our analysis of fire reports is providing a further means of evaluating this conclusion. We now should be able to give better answers to such questions as: Which fires should be bombed? How many fires per year should be bombed? How can the fires most susceptible to bombing be identified? How soon after these fires originate must bombing occur to be most effective?

B. Planning

1. Analysis of the fire control job in this region has provided further data showing the need for aerial bombing or other means of mechanized attack. Some fires cannot be dealt with successfully by hand-tool fire fighting alone even though the initial

attack is made quickly. Nearly 6 percent of the fires where the initial attack is made within one hour reach Class C or larger size. During the period 1931-1945 some 87 of these one-hour-attack fires reached sizes of over 300 acres. Paraphrasing from the military, we can't use infantry methods alone. More fire power is needed. In forest fire fighting aerial bombing may provide some of the needed fire power.

6. The job of manufacturing fuel moisture indicator sticks for all forest protective agencies west of the Mississippi River was transferred from the California region to our station in 1948. Some 1,500 sets of these sticks are used each year by federal, state, and private organizations. As there seemed to be an opportunity of reducing the cost, which had risen to $1.87 per set, and as our station not only originated but also formerly made these sticks, the California region transferred all equipment and supplies to our Priest River station. Accuracy and comparability will be guaranteed to within plus or minus one half of one percent at the lower, and dangerous, moisture contents.

By eliminating certain steps in oven drying and manufacturing, and by modifying others, the cost has been reduced to $1.50 per set in 1949. Other economies are expected to produce additional reductions despite the increased cost of the raw material. The Regional Office Spokane warehouse handles all shipping and billing, thereby reducing costs by taking advantage of their efficient organization. The arrangement affords off-season work for Priest River personnel and, since the station is reimbursed, it saves our regular funds.

9. Several talks were delivered before scientific associations and other groups interested in forestry. Gisborne gave talks before the New York Section of the Society of American Foresters, the annual meeting of the Western Forestry and Conservation Association, the University of Idaho School of Forestry, and the summer camp of the Iowa State College foresters. At Syracuse he made two radio "platters" which were used on a conservation radio program broadcast over a network of New York stations. Barrows delivered papers before the Montana Society of Engineers, the Northern Rocky Mountain Section of the Society of American Foresters, the Northwest Scientific Association, the Missoula Chamber of Commerce, and the Junior Chamber of Commerce. He appeared on a conservation radio program broadcast over a local station.

B. Plans for 1949

1. Fire Research plans for 1949 lack balance with the opportunities and needs. The fire control engineering studies to date have shown the importance of now undertaking more intensive work in fuel type classification; principles and techniques for the design of coordinated aerial and ground detection; strength and location

of control forces, especially on cutover lands and high mountain watersheds; and many other similar fields. Instead of starting work on these promising opportunities, lack of funds for fire research will restrict our efforts to very small-scale studies of only one or two items.

2. Fuel classification studies will receive the major emphasis during 1949. The effort will be directed toward a better determination of rate of spread according to burning index in the various major fuel conditions. This, in turn, is expected to lead to a better description of our fuel types and subsequently improved mapping and use in planning. Lack of funds will limit the study to rate of spread only and will leave the important factor of resistance to control for later investigations. Likewise, it is not anticipated that we will be able to undertake the vigorous program necessary to determine rate of transition in such fuels as logging slash, single burns, and bug- or disease-killed stands.

   The 1949 program will be devoted first to a re-examination of the needs and the basic assumptions of fuel typing; and second, to further analysis of rate of spread on specially selected fires which have occurred in areas adequately covered by fire danger stations. If funds permit, field studies will be made of past and present fuel classification in these test areas. In addition it is hoped to make a few test observations of rate of spread on going fires and prescribed burns. Our goal is to issue by 1950 a revised and improved guide for fuel type classification of the region, employing more accurate rates of spread than those assumed 15 years ago.

3. A report on the analysis of 35,000 fire reports will be prepared during 1949. This will explain the general nature of forest fires and the fire control job in northern Rocky Mountain forests. In a sense, it will be an encyclopedia of fire facts for this region. It is the first step toward preparation of the much bigger and more important publication, "Principles and Techniques of Fire Control Engineering." Preparation of this much needed guide will have to wait for the completion of other studies, especially fuel type classification and fire detection.

4. Two or three tests will be made of the possibility of dissipating incipient lightning storm clouds by treatment with dry ice. The Regional Office has agreed to finance these tests, which will cost about $600 each. They will be made in the Priest River area following Schaefer's written directions.

5. Two other Priest River jobs include (a) preparing a new set of 36 large logs so that this study of moisture content of heavy fuels may be continued; and (b) starting the manufacture of 1,500 sets of fuel moisture indicator sticks annually, to supply all agencies using this method.

6. Observations and lapse-time movies of controlled burns also will be commenced if possible, to acquire much needed information concerning fire behavior in heavy fuels.

FLOOD CONTROL SURVEYS

The Division of Flood Control Surveys was established at the Northern Rocky Mountain Forest and Range Experiment Station in early summer in order to meet the Forest Service flood control responsibilities in the headwaters of the Missouri and Columbia River watersheds. The new division was assigned responsibility for surveys in the upper Yellowstone and Missouri Rivers on the eastern slope of the Rocky Mountains, and the Clarks Fork, Kootenai, and other watersheds in the upper Columbia basin.

Recruitment of personnel progressed slowly. By late July four men were in the division, a fifth was added in November. However during the summer season, six additional technical people were secured on a detail basis from other Forest Service activities.

A. Accomplishments in 1948

1. Participation in Special Report of Columbia Flood of 1948. Four men from this Station participated in the emergency survey and special report on the 1948 Columbia River flood. Clerical help and transportation facilities were also made available for the survey.

   The 1948 flood was the greatest since 1894. More than 40 lives were lost and many thousands were made homeless. Total direct damages exceeded $200,000,000. Enormous soil losses were suffered on both fertile bottomlands and open upland slopes. Although meteorological conditions were the major causes of the flood, condition of the forest lands did affect headwater floods and the local damages. Fire was the most important factor which contributed to unfavorable watershed conditions; large volumes of water in the sub-alpine areas would have been held back by delayed snow melt if devastated areas had been forest covered.

   The study emphasized the lack of knowledge on the influence of forests on water relations in the Columbia River drainage.

2. Missouri River Watershed Survey. The survey of the Missouri watershed originally was set up for a period of several years. In order to bring the Department's program in line with those of other agencies, it was decided in late spring to make a general over-all survey of the entire basin and complete the report by the end of the calendar year. To meet the accelerated schedule, it was necessary to maintain close coordination with several Forest Service and Soil Conservation Service offices operating throughout the basin.

The specific areas assigned to this office included the mountainous areas of the upper Missouri and Yellowstone Rivers and all other forested lands in Montana and northern Wyoming.

Work on the Missouri started in June when the 1948 flood conditions were studied and a reconnaissance of the area was made. The Missouri flood was of less consequence than that on the Columbia but was very damaging in some localities. Actually the damage was caused by a series of local floods which resulted in part from rapid snow melt and in part from heavy rainfall. Areas most seriously damaged included the productive bottomlands above Great Falls, the Sun River irrigated lands, and the areas lying along the Shields River north of Livingston. As in the case of the Columbia flood, the results of past fires as reflected by bare slopes was the greatest single adverse watershed condition.

Six men on detail from other experiment stations and from Region 1 augmented the regular force for six weeks in mid- and late summer. All efforts were directed to field work designed to meet obligations for the over-all survey. Secondary data were supplemented by studies of large sample areas. Close contact was maintained with administrative agencies as well as survey crews from other offices.

After preliminary compilation and analysis, the survey material was combined and integrated with that of other Forest Service and Soil Conservation Service crews, and the rough draft of the report was prepared in late fall. Some changes, additions, and rearrangements have been made since the original draft was prepared. The report now awaits Departmental and Congressional action.

3. Survey of Clarks Fork (Columbia) Is Undertaken. Near the close of the year, plans were being made for the survey of the Clarks Fork drainage from its headwaters near Anaconda, Montana, to its confluence with the Columbia River on the Washington-Canadian boundary. The survey will extend over a period of about two years.

The major effort was concentrated at the Priest River Experimental Forest where two men were assigned to study snow-cover relationships. These flood control studies are essential to the successful analysis of the snow melt floods so prevalent in the Columbia basin. Existing facilities were used to good advantage and many instruments were secured on loan from other offices. Practically the entire time was spent in assembling, reconditioning and installing instruments and laying out snow courses. The major installations included

hygrothermographs, precipitation gages, anemometers, soil-air thermographs, and snow courses located on different aspects at different elevations and under varying amounts of tree cover. A stream gage with over 10 years of record forms the major control point. An over-snow machine was received in late December.

4. Other Activities. Many other activities and functions have received the attention of division personnel. During the course of the Missouri Survey, soil and humus conditions were observed and studied in lodgepole pine stands. Indications point out the need for careful analysis of watershed values and evaluation of potential site deterioration before any large scale commercial logging is undertaken. Results of the study are being prepared for publication in a technical journal.

A paper on the Forest Service aspects of the Missouri flood control survey was presented before the Forestry Section of the Northwest Science Association meeting in Spokane in December.

A short radio script on the Department's flood control activities was broadcast over a local radio station.

A month's training under the direction of the hydrologist at the Philadelphia office was given to a member of the division.

Contact has been maintained with the Upper Columbia Snow Laboratory.

The division has been represented in meetings of the CBIAC, MBIAC, Corps of Engineer Hearings, Montana Reclamation Association, Montana Missouri Council of State and Federal Agencies, and similar organizations and groups.

B. Plans for 1949

1. Clarks Fork Survey To Be Continued. The major activity in 1949 will be the collection of survey data for the Clarks Fork drainage. The studies at Priest River will be continued and all possible measurements and observations will be made prior to, during, and immediately following the rapid snow melt period. As the season progresses, erosion and soil moisture studies will be undertaken, the current winter measurements will be analysed, and steps taken to secure maximum data during the following winter season.

In addition to the Priest River project, sample watersheds will be selected for both winter and summer studies. Winter work will be associated with snow and runoff patterns; summer surveys will include work on soils, cover, humus, aspect, erosion, use, and treatment needs.

Damage, infiltration, economic, and other studies will be conducted concurrently with the work on small watersheds. Data available at the Upper Columbia Snow Laboratory and from other sources will be fully utilized.

It is expected that three or four professional employees will be added to the staff and will greatly expedite the survey activities in 1949.

2. Other Activities. Members of the division will continue to attend pertinent meetings and sessions relating to flood control work. These may include the Western Snow Conference, Interagency meetings, River Forecast Committees, and similar groups.

Assistance will be given in the preparation of comprehensive basin plans and other coordinating activities with the Department and Forest Service representatives in the Missouri and Columbia basins.

It is expected that the usual time will be devoted to preparation of radio material, news releases, material for training courses and meetings, field seminars, and other assignments of like nature.

DIVISION OF WILDLIFE RESEARCH

(Wildlife research is conducted by the U.S. Fish and Wildlife Service in cooperation with the Northern Rocky Mountain Forest and Range Experiment Station.)

A. Accomplishments in 1948

1. Research on the effects of deer browsing on ponderosa pine reproduction was continued. The reports on the 1946-47 field surveys are in various stages of completion. A brief report on the extent of deer browsing on ponderosa pine and Douglas-fir reproduction has been published in the "Proceedings of the Montana Academy of Sciences." A more complete report on the same subject has been completed except for minor revision. This report is to be submitted for publication in the Journal of Forestry. Information obtained by the field surveys shows that on the Fisher River study area, where ponderosa pine competes with the economically inferior Douglas-fir, deer browse heavily on both pine and fir reproduction. This browsing is greatest in late winter. The pine is browsed more intensively than the fir, a process which favors the competitive status of the fir. Probably the intensity of browsing could be alleviated by improving the general condition of winter deer range so that browse species more palatable than conifers would become more abundant, and by reducing the number of deer so the demand for winter forage would be lessened. The adverse influence of browsing probably could be reduced by increasing the germination of pine seeds and development of seedlings through improved silvicultural practices.

2. Conditions on the seven deer exclosures on Cow Creek and Richards Creek were surveyed again this spring. The check plots outside the exclosures were replanted with ponderosa pine seedlings in the autumn of 1947. There was heavy browsing of these plantations by deer. There is no evidence of recovery of the vegetation in the exclosures, but photographs of the plots show that the amount of accumulated dead grass and forbs is greater in some of the exclosures than they were last year. Most of the planted seedlings within the exclosures are surviving and appear to be in good condition. An unknown factor is causing the loss of the needles of a few plants. The percentage of survival of the plants in the exclosures will demonstrate the ability of the pine seedlings to survive adversities other than deer browsing. Surveys of forage species other than conifers have been made each year on the exclosures and check plots. Data from these surveys will show the nature and rate of recovery of the deer range in the

absence of use by deer as well as the vegetative trends under existing conditions of use. Of special interest in this regard are data on the rates of production and consumption of "black moss" (Alectoria). This lichen grows on the limbs of trees and becomes available to deer only as it is blown down or comes down with falling trees. Deer show a marked preference for this source of food and chemical analyses have shown that it is richly nutritious. There is some evidence that the rate of consumption of Alectoria is correlated with the number of deer using the winter range. The moss may furnish a useful index to deer populations and also to intensity of range use.

As indicated in the last annual report, the studies of deer browsing on ponderosa pine, while indicating the extent of browsing, have not shown the effect of given amounts of browsing on survival and growth of the trees. Plans for an experiment to give information on this were activated this spring. In Rattlesnake Canyon near Missoula, ponderosa pine reproduction of three height classes were subjected to artificial or simulated browsing at two intensities. Experimental trees are 0.5 to 1.4, 1.5 to 2.4, and 2.5 to 3.4 feet tall. "Browsing" intensities are one half of all lateral buds plus the terminal bud, terminal bud only, and none. Another modification of intensity provides for applying the "browsing" treatment to different trees every year, every other year, and every third year. Each treated tree is matched with a paired untreated control tree. The experiment is replicated in ten blocks of 36 trees each. The initial treatments were applied this spring. Deer repellent is to be applied to the experimental trees each fall to deter deer from browsing them.

2. A popular report of the 1947 studies of DDT in Idaho and Wyoming was published in "Outdoor Montana," a sportsmen's publication. A technical report on the same subject has been submitted to "The Journal of Wildlife Management," and is to appear in the April, 1949 issue.

A new insecticide, Toxaphene, has been introduced in the control of grasshoppers. Its effects on wildlife were studied by Mr. Thomas D. Burleigh, Ornithologist, Fish and Wildlife Service, and Lowell Adams, the Station's cooperating Fish and Wildlife Service Biologist. Toxaphene is the trade name for chlorinated camphene, a by-product of turpentine. It was applied to 50,000 acres of short-grass prairie in south-central Montana. Land animals showed no adverse effects. Several tiger salamander larvae in a stock pond were killed, but apparently some lived so that recovery of population numbers may be expected. A few frogs were killed, but not enough of them died to affect population numbers appreciably. No fish were seen during the study so there was no opportunity to study their reactions. It is reported that Toxaphene is lethal to fish.

3. Studies of small mammals in relation to reforestation were initiated. Of fundamental importance to both natural and artificial forest regeneration is the abundance of seed-eating wildlife. A limited number of seeds of white pine and ponderosa pine drop to the ground each year. The amount of these seeds that are eaten by mice, chipmunks, shrews and squirrels is proportional to the number of these animals present. It may commonly happen that too few seeds are left by the rodents and shrews to allow for adequate reproduction. It is important, therefore, to anticipate the production and consumption of seed in areas of critical regeneration with a view to controlling seed destruction whenever desirable. To meet this need, a research program is being developed to provide means for determining the rate of seed destruction in relation to amount of seed produced and number of animals present, and the best methods for control wherever destruction exceeds maximum tolerable limits.

Lack of manpower and facilities prevents a complete coverage of the group of relationships involved in seed production and survival and animal consumption and control. As resources allow, therefore, we have attacked certain aspects of the problem. One of these is animal populations. In cooperation with the Johns Hopkins "North American Census of Small Mammals" trap lines are operated each spring and fall in typical white pine and ponderosa pine habitats. Trapping returns will furnish an index to population trends. Stomachs are saved in hopes that facilities may become available for the analysis of contents to determine the extent of pine seed consumption. Additional data on life histories and disease are available from the trapped animals and should be obtained for use in analyzing population cycles and in developing control measures if facilities for such work become available. Two trap lines were established this year on the Deception Creek Experimental Forest. One of them is in the Montford Creek Preserve - a virgin white pine stand which will not be logged. The other is in an area which was clear cut in 1935 and is being reforested by natural regeneration. Three trap lines were established in the ponderosa pine type in northwestern Montana near Warland. These are maintained in conjunction with an experiment of the Division of Forest Management to study seed production and to develop methods for seed-bed preparation. The trap lines are related to experimental areas which are variously treated by scarification and burning after selective logging. Seed traps are set out to measure the amount of seed falling to the ground. This will be compared with the number of seeds which survive the various destructive agencies, including animals, through the period of germination. There was an unusually large population of white-footed mice in the area and their stomachs appear to contain pine seeds, although there are no manpower

and facilities to identify and quantitatively to evaluate the seeds eaten. Also there was an unusually large crop of pine seed produced this fall and winter. The limited studies will therefore be particularly valuable this year in furnishing data on a combination of circumstances which may not occur again for a number of years. Unfortunately it was impossible to collect trapping data on a scale which would provide desired statistical reliability. For example, there was not sufficient manpower available to establish trap line replications in each of the burning-scarification treatment areas.

Assistance was given a Division of Forest Management special project in direct seeding in eastern Washington. Various methods and degrees of pregermination and stratification of white pine seed were tested with a view to speeding the germination of planted seeds. Such a speed-up would decrease the period of exposure to seed-destroying agents. Animals on the experimental area on Blickensderfer Creek were line trapped, marked and released, and a report on the number of animals trapped and seen was submitted to the Division of Forest Management.

Some progress was made in the anlysis of results of the study plots established before the war to determine the extent of damage by rabbits to white pine plantations. These plots in northern Idaho received no attention during the war years. Rabbit-proof fences deteriorated and there are no data for those intermediate years. However, a salvage job is in order to make use of whatever evidence is available from the plots and as a basis for further planning of studies to reveal the facts needed for evaluating and controlling rabbit damage to plantations. Two experimental plots on the Kaniksu and Coeur d'Alene National Forests were studied and data were tallied on them. Another plot on the St. Joe Forest proved to be inaccessible because of unusually wet weather causing impassable roads on the two occasions when visits were attempted. Later efforts were impossible because of lack of manpower and the press of other duties. The St. Joe plot will be attempted next year followed by a report of data available and plans for further study.

4. Considerable time is devoted to miscellaneous consultative services, meetings, educational efforts, and the like. These activities are contributions to institutions, communities, and individuals concerned with wildlife management, research, and education. Following is a partial, representative list of this type of activity with a note on the identity of the group or individuals served:

Showed the film, "Wildlife of Denali", to members of a club, a church, a parent-teachers' association, twelve schools, and a university, 21 showings in all.

Presented the Division of Wildlife Research program at the annual public meeting of the Northern Rocky Mountain Forest and Range Experiment Station.

Held conference on conservation education with Dean Kenneth P. Davis, School of Forestry; Dean J. W. Maucker, School of Education; Dr. J. W. Severy, Chairman, Department of Biological Sciences, Montana State University; and L. A. Campbell, Information and Education, U. S. Forest Service.

Served as Board Member on the Board of Directors and as Chairman of the Education Committee of the Western Montana Fish and Game Association.

3. Initiated action and helped carry through to completion the organization of the Northern Rocky Mountain Wildlife Society, a Section of the National Wildlife Society. Served as Secretary of the Society during its first year.

Conducted field trips in connection with deer exclosure studies on which senior students in range management of Montana State University assisted in plot surveys.

Organized and acted as Chairman of the Big Game Range Committee of the Northern Rocky Mountain Wildlife Society.

7. Initiated action and helped to organize a tri-weekly, 15-minute radio program with participation by about 25 organizations - federal, state, community, and private.

Many informal consultations and services were contributed to organizations in addition to those mentioned. These include the University of Idaho, the Forest Insect Control Laboratory in Idaho, Glacier National Park, Yellowstone National Park, the Bureau of Entomology and Plant Quarantine, State Fish and Game Departments of Idaho, Washington, Montana, and Wyoming, the U. S. Forest Service, Washington State College, and Johns Hopkins University in Baltimore, Maryland.

5. For approximately three months, September to December, the Biologist and sole member of the Division of Wildlife Research attended a Service Training course in Statistical Methods given by the Forest Service in Washington, D. C.

6. Routine activities which use an unreasonable share of the Biologist's time include all the fiscal, personnel, and operational activities of the office which should ordinarily be done by secretarial help.

B. Plans for 1949

1. On the problem of deer and pine reproduction, the report on intensity of browsing will be finished and submitted to the Journal of Forestry for publication. During the 1947 field survey, considerable data were acquired on the relationship of conifers to other browse species on the winter deer range. These data will be analyzed and prepared for publication. Simulated browsing studies will receive regular spring and fall attention. The deer exclosures will be surveyed in the spring.

2. The only activity expected in insecticide investigations will be the publication of the report on DDT in the Journal of Wildlife Management. Requests for additional services on this kind of problem have been discouraged because of the lack of manpower and the interruptions they cause on regularly scheduled projects.

3. The Johns Hopkins small mammal population studies will continue. Related studies of forest seed production and consumption will also continue under planned programs already established.

4. Surveys of rabbit study plots will be finished and a report made on the plots and proposed future activities.

5. Miscellaneous contacts, consultations, and services will be carried on approximately as in the past.

6. Routine office activities will continue.

7. There is a possibility that funds may become available for a one-student summer project in 1949. If this materializes, a project will be set up to study techniques for food habits determinations of herbivorous animals. This is desirable to furnish tools for the analysis of the food habits of big game and small animals in relation to the forest economy.

DIRECT AND INDIRECT COSTS BY FINANCIAL PROJECTS

F. Y. 1949

Financial Project	Indirect project costs (overhead)	Direct project costs	Total costs
Forest & Range Management	$ 15,425	$ 138,824	$154,249
Forest Products	---	19,500	19,500
Forest Resources Investigations	5,850	52,650	58,500
Flood Control	6,000	57,500	63,500
Total	$ 27,275	$ 268,474	$ 295,749

DISTRIBUTION OF DIRECT COSTS BY MAIN PROJECTS

F. Y. 1949

Financial and work project	Cars, maintenance & new	Equipment, misc.	Travel expenses other than cars	Salaries		Total
				Regular	Temp.	
FOREST & RANGE MANAGEMENT INVES.						
501	$ 3,800	$ 9,049	$ 3,946	$ 36,103	$ 9,311	$ 62,109
503	150	3,018	836	8,175	830	13,011
510	200	900	918	4,449	---	6,467
520	150	1,080	800	19,427	1,724	23,161
540	400	1,976	1,800	29,402	498	34,076
Total	4,700	15,993	8,202	97,556	12,373	138,824
FOREST PRODUCTS	200	1,397	2,400	15,503		19,500
Total	200	1,397	2,400	15,503		19,500
FOREST RESOURCES INVESTIGATIONS						
601	400	1,708	3,400	19,974	618	26,100
602	1,950	447	1,695	14,729	1,429	20,250
610	20	200	600	5,480	---	6,300
Total	2,370	2,355	5,695	40,183	2,047	52,650
FLOOD CONTROL	6,450	2,250	9,662	36,766	2,372	57,500
Total	6,450	2,250	9,662	36,766	2,372	57,500
Grand Total	13,720	21,995	25,959	190,008	16,792	268,474

Finch, T. L.
Effect of bark growth in measurement of periodic growth of individual trees. Research note 60. 3 pp. Stenalith. March 1948.

Forest Economics
Forest survey manual of field instructions. Revision April 1948. 51 pp. Mimeo.

Forest Utilization Service
Review of tie specifications and prices in the northern Rocky Mountain area as of May 1948. 2 pp. Mimeo. June 1948.

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Dry ice to make rain and stop lightning. Proc. 39th ann. meeting Western Forestry & Conservation Assoc., Victoria, B. C. Dec. 1948.

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_____ Fundamentals of fire behavior. Fire Control Notes 9:13-24. January 1948.

Harris, Grant A.
A selected bibliography of range management literature published in 1947. 14 pp. Mimeo. Vol. 1, no. 2. October 1948.

Helmers, Austin E.
Early results from thinning seed spots. Research note 58, 5 pp. Stenalithed. January 1948.

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Pole production continued upward in 1947. Research note 62. 3 pp. Stenalithed. April 1948.

Hurtt, Leon C.
The problem of the plains. The Hereford Journal. January 1, 1948.

_____ The types of plains vegetation. U. S. Dept. Yearbook of Agriculture, pp. 484-486. 1948.

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Hutchison, S. Blair
Comparative marketability of pine and mixed species in the Inland Empire. Research note 64. 5 pp. Stenalithed. June 1948.

Kemp, P. D. and Metcalf, M. E.
Tables for approximating volume growth of individual trees. Station paper 11. 14 pp., tables. Stenalithed. March 1948.

LeBarron, Russell K.
Cutting lodgepole pine in the northern rocky mountains. Proc. Soc. Amer. Foresters' meeting, Minneapolis, 1947. Pp. 399-403.

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Slash disposal by spot burning and dozer piling in ponderosa pine type. Paper presented at meeting of NRM Section, S.A.F., Missoula, Mont., March 19, 1948. 9 pp., mimeo.

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Review of published information on the larch-Douglasfir type. Station paper 15. 14 pp., illus. Stenalithed. November 1948.

_____ and Wellner, C. A.
Review of plants and environment. A Textbook of Plant Autecology, by R. F. Daubenmire. Jour. Forestry 46(9):700-701. 1948.

Matthews, Donald N., and Hutchison, S. Blair
Development of a blister rust control policy for the national forests in the Inland Empire. Station paper 16. 119 pp., tables & figs. Stenalithed. December 1948.

Mueller, Lincoln A.
Protection of rustic finishes against mold attacks. Research note 61. 2 pp., mimeo. April 1948.

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Cottonwood railway tie test completed. Research note 67. 2 pp. Stenalithed. December 1948.

Pissot, H. J. and Peffer, E. F.
Forest resource statistics, Cascade County. Station paper 12. 22 pp., tables. Stenalithed. April 1948.

Roe, Arthur L.
Growth rate of selectively cut ponderosa pine in western montana. Proc. Mont. Acad. Sci., vol. 7 and 8, pp. 15-23, illus. 1948.

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What caused "blight" on Christmas trees in the northern rockies in 1947? Research note 65. 5 pp., mult. July 1948.

Roe, Arthur L.
A preliminary classification of tree vigor for western larch and Douglas-fir trees in western Montana. Research note 66, 6 pp., illus., mult. November 1948.

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Thirty-nine years' growth in a cut-over larch stand. Research note no. 70. 6 pp., mult., illus. December 1948.

Rogler, George A. and Hurtt, Leon C.
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Wellner, C. A.
Light intensity related to stand density in mature stands of the western white pine type. Jour. Forestry 46(1):16-19. January 1948.

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New disease threatens western white pine stands. Jour. Forestry 46(4):244-295. April 1948.

2. Departmental Publications Planned for F.Y. 1949

Survey report, Missouri River watershed - program for runoff and waterflow retardation and soil erosion prevention. To be prepared jointly by Soil Conservation Service and Forest Service.

Tebbe, C. L. and Andrews, H. J.
Private forestry in the west. U. S. Dept. Agriculture Yearbook 1949.

Woolfolk, E. J.
Stocking northern great plains sheep range for sustained high production. U. S. D. A. circular no. 804.

3. Departmental Publications Planned F.Y. 1950

Friedrich, C. Allan
Testing forage species for reseeding central Montana range lands. U.S.D.A. circular.

Hurtt, Leon C. and Woolfolk, E. J.
Management of northern great plains cattle ranges to minimize effects of drought. U.S.D.A. circular.

Reed, M. J. and Peterson, R. A.
Response of northern great plains vegetation and soil and cattle to three rates of range stocking. U.S.D.A. technical bulletin.

Forest resources and forest industries of Montana.

4. Other Publications Planned for Release in 1949

Adams, Lowell
The winter diet of white-tailed deer in Montana in relation to forest regeneration.

_____
Confidence limits for the Lincoln index - a statistical refinement in wildlife population studies.

_____
An inexpensive punch-card system suitable for wildlife research and management jobs with small samples.

_____
Third annual report on white-tailed deer exclosure plots on the Fisher River, Lincoln County, Montana.

_____, L. Mitchell, G. Hannavan, Neil W. Hosley and David W. Johnston
The effects on fish, birds, and mammals of DDT used in the control of forest insects in Idaho and Wyoming. (Now in press.)

Anderson, I. V.
Suitability of Douglas-fir for production of pulp and paper. Research note.

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Suitability of lodgepole pine for production of pulp and paper. Research note.

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Suitability of ponderosa pine for production of pulp and paper. Research note.

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Suitability of western larch for production of pulp and paper. Research note.

Barrows, J. S.
Forest fires in the northern rocky mountains. Station paper.

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Bombing forest fires in the northern rocky mountains. Station paper.

Evanko, Anthony B.
Sagebrush burning studied - need for reseeding indicated. Montana Farmer-Stockman.

Forest Utilization Service
Partial list of treating plants and pole and post yards in Montana, northern Idaho, and eastern Washington. 4 pp., mimeo.

_____
Review of tie specifications and prices in the northern rocky mountain area as of May 1949. 2 pp., mimeo.

Friedrich, C. Allan
An analysis of results of recent range plantings on the national forests of region one. Research note or station paper.

_____
Seasonal development 14 promising grasses for reseeding Montana ranges. Research note.

_____ and Heik, E. E.
Hard fescue - a rugged new grass for reseeding Montana ranges. Farm or livestock journal article.

Gisborne, H. T.
Problems and probabilities of the critical fire season. Station paper or Journal of Forestry article.

_____
Minimum rate fire insurance. Research note.

Haines, A. L.
An annotated bibliography on the use of aircraft in forest fire control. (In cooperation with the School of Forestry, Montana State University.) Station paper.

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An annotated bibliography on forest fire behavior. (In cooperation with the School of Forestry, Montana State University.) Station paper.

Huey, Ben M.
Christmas tree shipments increase. Research note 71. January 1949.

Hutchison, S. Blair and Huey, Ben M.
Suggested Montana Douglas-fir Christmas tree standards.
Station paper no. 18. January 1949.

Kemp, Paul D. and Pissot, H. J.
Forest resource statistics for northeast Washington.
Station paper.

Meik, Eldon E.
A cost-benefit analysis of seeding abandoned farm land to crested wheatgrass by the preparatory crop method. Research note.

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Response of crested wheatgrass to ammonium sulphate fertilizer.
Farm or livestock journal article.

Mueller, Lincoln A.
Suitability of ponderosa pine for production of veneer and plywood. Research note.

_____
Suitability of western larch for production of veneer and plywood. Research note.

_____ and Wikstrom, John H.
Depreciation in white pine logs caused by river driving.
Station paper.

Roe, Arthur L.
Response of western larch and Douglas-fir to logging release in western Montana. Mss. submitted to Northwest Science.

Trimble, G. R. (Jr.) and Tripp, Norman R.
Some effects of fire and cutting on forest soils in the lodgepole pine forests of the northern rocky mountains. To be published in Journal of Forestry.

Woolfolk, E. J. and Knapp, Bradford, Jr. (B.A.I.)
Weight and gain of range calves as affected by rate of range stocking. Montana State Agricultural Experiment Station bulletin.

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Forest resource statistics for southern Montana.
Station paper.

Forest resource statistics for Units I and II, North Idaho.
Station paper.

Marketing Montana Christmas trees. To be published in cooperation with the Montana State University, School of Forestry.

Pole production statistics. Research note.

Pulpwood production statistics. Research note.

Summarizing five-year results on mortality and growth following partial cutting in mature white pine stands. Station paper.

Reporting a tree vigor classification for use in partial cutting in the western white pine type. Station paper.

Revision of station paper no. 3, "Blister Rust Control in the Management of White Pine."

Poisoning western hemlock and grand fir. Research note.

A report summarizing sample tree measurement.

Growth and cutting practices in the larch-Douglasfir type in western Montana. Station paper.

Growth and cutting practices in the ponderosa pine type in western Montana. Station paper.

Discussing successional trends in a cut-over larch-Douglasfir stand. Research note.

PERSONNEL OF STATION - DECEMBER 31, 1948

OFFICE OF DIRECTOR

Chas. L. Tebbe	Director
Norman L. Henry	Administrative Assistant
S. Dagmar Nelson	Clerk

DIVISION OF FIRE RESEARCH

Harry T. Gisborne (Chief)	Forester
Jack S. Barrows	Forester
Mary C. Bowler	Clerk-stenographer
Albert W. Peiffer	Forestry Aid (Research)

DIVISION OF FOREST MANAGEMENT RESEARCH

Russell K. LeBarron (Chief)	Silviculturist
Grace D. Ehlers	Clerk-stenographer

FOREST UTILIZATION SERVICE

Irvin V. Anderson (Chief)	Forester
Lincoln A. Mueller	Forester
Marie E. Bouchard	Clerk-stenographer

DIVISION OF RANGE RESEARCH

Leon C. Hurtt (Chief)	Range Examiner
Laurence R. Short	Range Conservationist (Research)
C. Allan Friedrich	Range Conservationist (Research)
Roald A. Peterson	Range Conservationist (Research)
Merton J. Reed	Range Conservationist (Research)
Anthony B. Evanko	Range Conservationist (Research)
Eldon E. Meik	Range Conservationist (Research)

DIVISION OF FLOOD CONTROL SURVEYS

Martin E. Baudendistel (In Charge)	Conservationist
Norman R. Tripp	Forester
Paul A. Ingebo	Hydrologist
Austin E. Helmers	Forester
DeWilton C. Smith	Forester (Research)
Onnolee V. Peffer	Clerk-stenographer

DIVISION OF FOREST ECONOMICS

Murlyn B. Dickerman (Chief)	Forest Economist
S. Blair Hutchison	Forest Economist
Paul D. Keap	Forester
Ben M. Huey	Forester
Clarence W. Brown	Forester
Thomas L. Finch	Forester
William C. Hodge	Forester
Gordon A. Hutton	Forester
Elwyn F. Peffer	Forester
Melvin E. Metcalf	Forestry Aid (Research)
Henry J. Pissot	Forestry Aid (Research)
John H. Wikstrom	Forestry Aid (Tbr. Mgt.)
Monica E. Hobe	Clerk-stenographer

PRIEST RIVER RESEARCH CENTER

Charles A. Wellner	Forester
Marvin W. Foiles	Forester (Research)
Richard F. Watt	Forester (Research)
Albert W. Peiffer	Forestry Aid (Research)
T. S. Buchanan, Univ. of Idaho	Collaborator

SPOKANE RESEARCH CENTER

Charles A. Wellner	Forester
Donald W. Lynch	Silviculturist
Grant A. Harris	Range Conservationist (Research)
Florence R. Olson	Clerk-stenographer

WESTERN MONTANA RESEARCH CENTER

Arthur L. Roe	Silviculturist
Ben M. Huey	Forester
Kenneth N. Boe	Silviculturist
Anthony E. Squillace	Silviculturist
Marie Van Loon	Clerk-stenographer

DIVISION OF FOREST WILDLIFE INVESTIGATIONS
(In cooperation with Fish and Wildlife Service)

Lowell Adams	Biologist

FIELD STATIONS

Deception Creek Experimental Forest	Marvin W. Foiles
Priest River Experimental Forest	Austin E. Helmers
Miles City Experimental Range	Laurence R. Short
Vigilante Experimental Range	Anthony B. Evanko